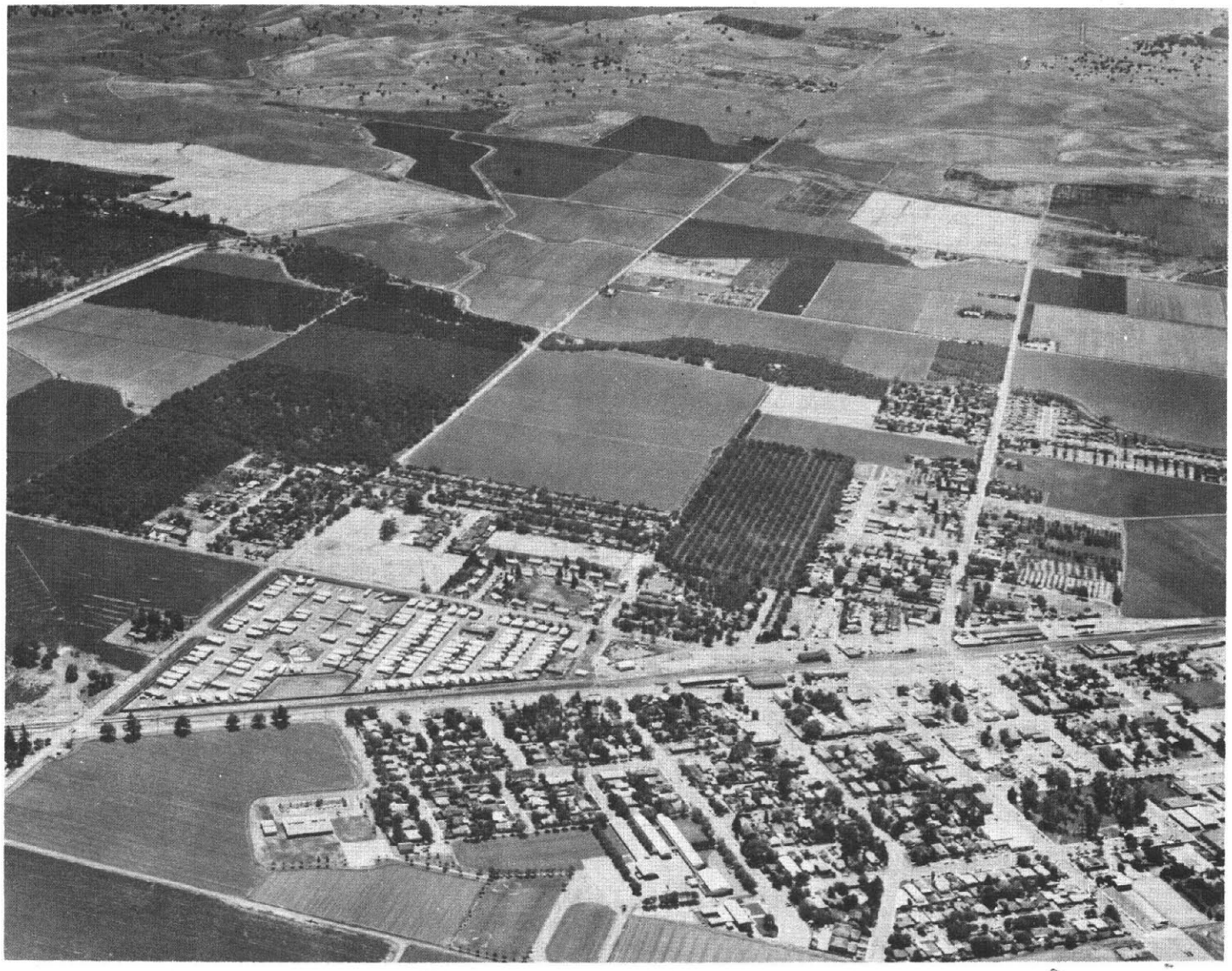
SOIL SURVEY OF

Contra Costa County, California



United States Department of Agriculture
Soil Conservation Service
In cooperation with
University of California
Agricultural Experiment Station

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all who need the information, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1962-72. Soil names and descriptions were approved in 1973. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1973. This survey was made cooperatively by the Soil Conservation Service and the University of California Agricultural Experiment Station. It is part of the technical assistance furnished to the Contra Costa Resource Conservation District.

Soil maps in this survey may be copied without permission, but any enlargement of these maps could cause misnnderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, woodlands, and wildlife areas; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of Contra Costa County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification and Storie index rating of each. It also shows the page where each soil is described and the page for the range site in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the range sites and capability units.

Wildlife managers and others can find information about soils and wildlife in the section "Wildlife."

Ranchers and others can find, under "Range," groupings of the soils according to their suitability for range and the names of many of the plants that grow on each range site.

Engineers and builders can find, under "Engineering Uses of the Soils," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Scientists and others can read about the soils in the section "Formation and Classification of Soils."

Newcomers in the county may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given in the section "General Nature of the County."

Cover: City of Brentwood, in 1975, surrounded by fruit and nut crops and field crops on Brentwood and Sorrento soils. Rangeland, in the background, is Altamont soil.

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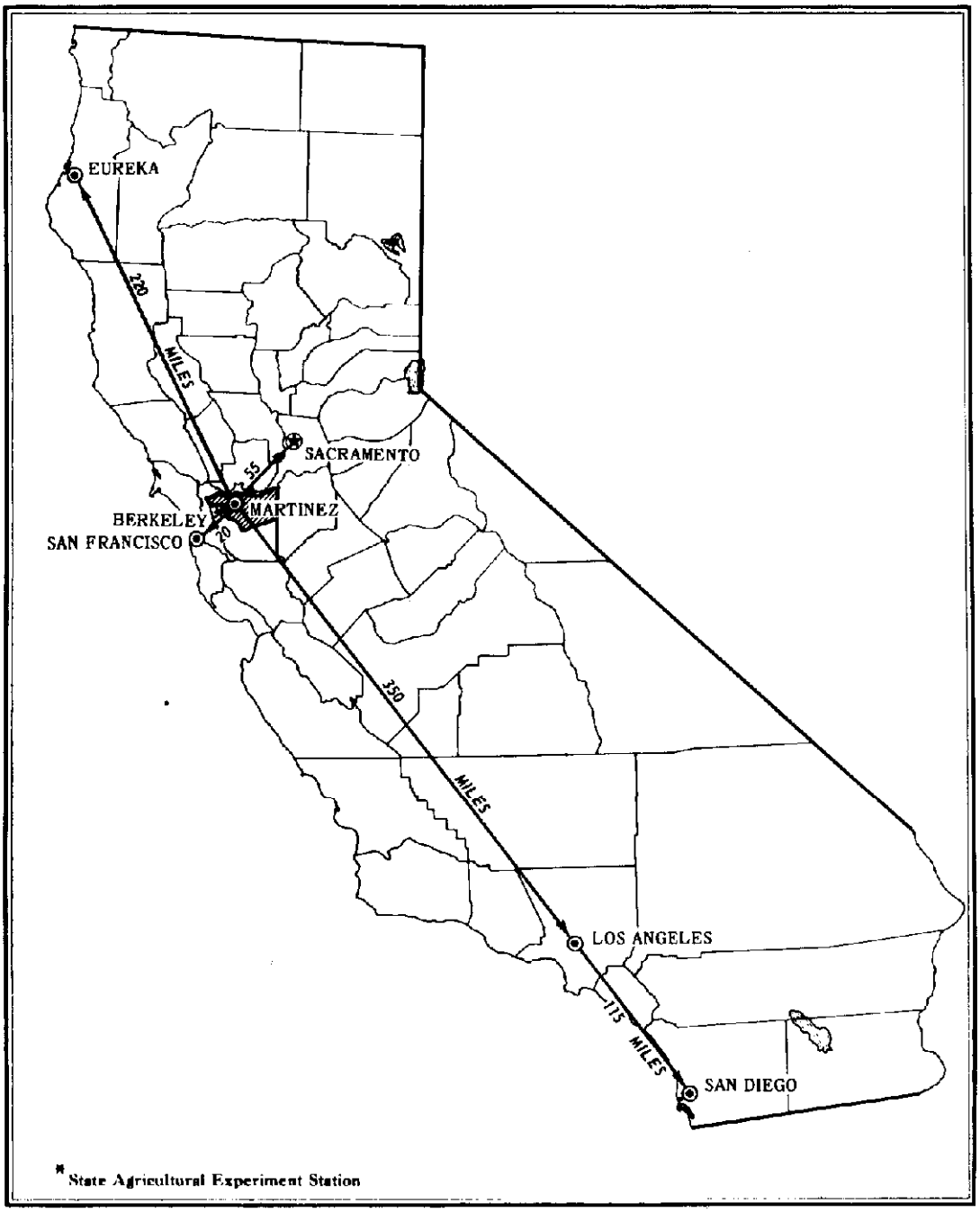

Location of Contra Costa County in California.

SOIL SURVEY OF CONTRA COSTA COUNTY, CALIFORNIA

BY LAWRENCE E. WELCH, SOIL CONSERVATION SERVICE

FIELDWORK BY LAWRENCE E. WELCH, DAVID K. MAURER, CLIFFORD LANDERS, PAUL C. NAZAR, AND WILLIAM A. GASTON, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH UNIVERSITY OF CALIFORNIA AGRICULTURAL EXPERIMENT STATION

CONTRA COSTA COUNTY is in the west-central part of California. It lies southeast of San Pablo Bay and south of Suisun Bay. The north-central part borders the confluence of the Sacramento and San Joaquin rivers. Contra Costa County is bounded on the west by San Francisco and Marin Counties, on the south by Alameda County, on the east by San Joaquin County, and on the north by Sacramento and Solano Counties.

Contra Costa County has an area of 468,650 acres. The eastern part of the county, within the San Joaquin Valley and Sacramento-San Joaquin Delta, is nearly level and is intensively cultivated. The nearly level to sloping valleys in the central part of the county are used mainly for urban development, but some areas are dryfarmed to small grains and a few are in walnut orchards. The rest of the county consists of strongly sloping to very steep uplands used for range. The dominant landmark of the county is Mount Diablo, which is 3,849 feet high.

The most highly developed urban and industrial areas are Concord, Richmond, Walnut Creek, Pittsburg, and the unincorporated areas in the central part of the county.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Contra Costa County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and, perhaps, some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams and rivers, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Egbert and Joice, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soil by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Diablo clay, 15 to 30 percent slopes, is one of several phases within the Diablo series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show roads, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map in the back of this publication was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

In most areas surveyed there are places where the soil is so rocky or so disturbed or covered by urban or industrial structures that is cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Urban land is a land type in Contra Costa County.

Some mapping units are made up of soils of different series or of different phases within one series. Two such kinds of mapping units are shown on the soil maps of Contra Costa County: soil complexes and soil associations.

A soil complex consists of areas of two or more soils, so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Fontana-Altamont complex is an example.

A soil association is made up of adjacent soils that are in areas large enough to be shown individually on the soil map but are shown as one unit because the time and effort of delineating them separately cannot be justified. There is a considerable degree of uniformity in pattern and relative extent of the dominant soils, but the soils may differ greatly one from another. The name of an association consists of the names of the dominant soils or land types, joined by a hyphen. Rock outcrop-Xerorthents association is an example.

While a soil survey is in progress, samples of soils are taken as needed for laboratory measurements and engineering tests. Laboratory data from the same kinds of soil in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil. Yields under defined management are estimated for all the soils.

Only part of a soil survey is completed when the soils have been named, described, and delineated on the map and the laboratory data and yield data have been assembled. The mass of detailed information must then be organized in such a way as to be readily useful to different groups of users, among them farmers, managers of range, and engineers.

On the basis of yield and practice tables and other data, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others, then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this publication shows, in color, the soil associations in the survey area. A soil association is a landscape that has a distinctive pattern of soils in defined proportions. It typically consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association can be in other associations as well, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a survey area, who want to compare different parts of that area, or who want to locate large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area or in planning recreation facilities, community developments, and such engineering works as transportation corridors. It is not a suitable map for planning in detail the management of a farm or field or for selecting a site for a road or building or other structure, because the soils within an association ordinarily vary in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations in this county have been grouped into general kinds of landscapes for broad interpretative purposes. Each of the groups and the soil associations are described on the following pages.

Nearly Level to Strongly Sloping, Somewhat Excessively Drained to Very Poorly Drained Soils on Valley Fill, Basins, Low Terraces, Flood Plains, and Alluvial Fans

These soils range from sand to clay. They formed mainly in alluvium from mixed, mostly sedimentary rocks. A small area of these soils formed in wind-modified stream deposits. Slopes are 0 to 15 percent.

Elevation ranges from sea level to 1,500 feet. The average annual rainfall is 10 to 25 inches. The average annual temperature is 59° to 60° F., and the frost-free season is 250 to 330 days. Most of the soils in the eastern part of the county are cultivated. In the western and central parts of the county, most of the soils are in residential and other urban uses.

The six soil associations in this group make up 26 percent of the county.

1. Brentwood-Rincon-Zamora association

Nearly level to gently sloping, well-drained clay loams and silty clay loams on valley fill, alluvial fans, and low terraces

The soils in this association are very deep. They formed in alluvium from sedimentary rock. Slopes range from 0 to 5 percent, although most slopes are 0 to 2 percent. Elevation ranges from 40 to 500 feet. The average annual rainfall is 12 to 24 inches. The average annual temperature is 59° to 60° F., and the frost-free season is 250 to 330 days.

This association makes up about 5 percent of the county. It consists of about 35 percent Brentwood soils, 30 percent Rincon soils, and 20 percent Zamora soils. The rest is Sorrento, Los Robles, Capay, Garretson, Sycamore, and Kimball soils.

Brentwood soils have a surface layer of grayish-brown clay loam. The upper part of the subsoil is brown heavy clay loam. The lower part of the subsoil and the substratum are yellowish-brown clay loam and silty clay loam.

Rincon soils have a surface layer of dark grayish-brown clay loam and a subsoil of brown clay. The substratum is light yellowish-brown silty clay loam and loam.

Zamora soils have a surface layer of grayish-brown and dark grayish-brown silty clay loam. The subsoil is

dark grayish-brown and brown silty clay loam. The substratum is grayish-brown light clay loam.

Many kinds of crops are intensively cultivated, and the soils are commonly used for residential development. In the eastern part of the county, the soils are used for irrigated orchards, row crops, and field crops. Walnuts, almonds, and apricots are the principal orchard crops. Tomatoes, head lettuce, and sugar beets are the principal row crops. Alfalfa hay is the principal field crop. The wildlife is mainly upland game that requires supplemental feed and cover.

2. *Capay-Sycamore-Brentwood association*

Nearly level, moderately well drained, poorly drained, and well drained clays, silty clay loams, and clay loams on valley fill and flood plains

The soils in this association are very deep and have a perched water table between depths of 40 and 60 inches. They formed in alluvium from sedimentary rock. Slopes are 0 to 2 percent. Elevation ranges from 10 to 500 feet. The average annual rainfall is 14 to 18 inches. The average annual temperature is 59° F., and the frost-free season is 250 to 300 days.

This association makes up about 3 percent of the county. It consists of about 50 percent Capay soils, 20 percent Sycamore soils, and 15 percent Brentwood soils. The rest is Rincon and Laugenour soils.

Capay soils are moderately well drained. They have a surface layer of dark grayish-brown and grayish-brown clay. The substratum is brown clay and yellowish-brown silty clay loam.

Sycamore soils are poorly drained. They have a surface layer of grayish-brown silty clay loam and a subsoil of mottled brown heavy silt loam. The substratum is mottled brown silty clay loam that has lenses of loamy fine sand.

Brentwood soils are well drained to moderately well drained. They have a surface layer of grayish-brown clay loam. The upper part of the subsoil is brown heavy clay loam. The lower part of the subsoil and the substratum are yellowish-brown clay loam and silty clay loam.

In the eastern part of the county, the soils are intensively cultivated. Almonds and apricots are the principal irrigated orchard crops. Tomatoes, sugar beets, and head lettuce are the principal row crops. Alfalfa is the principal field crop. In other areas, the soils are used for urban and industrial development. The wildlife is mainly upland game that requires supplemental feed and cover.

3. *Capay-Rincon association*

Nearly level to strongly sloping, moderately well drained and well drained clays and clay loams on valley fill

The soils in this association are more than 60 inches deep. They formed in alluvium from sedimentary rock. Slopes are 0 to 15 percent. Elevation ranges from 50 to 500 feet. The average annual rainfall is 12 to 16 inches. The average annual temperature is 59° F., and the frost-free season is 250 to 300 days.

This association makes up about 3 percent of the county. It consists of about 50 percent Capay soils and 40 percent Rincon soils. The rest is Antioch, Brentwood, and Sycamore soils.

Capay soils are moderately well drained. They have a surface layer of dark grayish-brown and grayish-brown clay. The substratum is brown clay and yellowish-brown silty clay loam.

Rincon soils are well drained. They have a surface layer of dark grayish-brown clay loam and a subsoil of brown clay. The substratum is light yellowish-brown silty clay loam and loam.

These soils are used for irrigated row crops, field crops, and orchards. They are also used for dryfarmed grain, hay, and urban and industrial development. The wildlife is mainly upland game that requires supplemental feed and cover.

4. *Delhi association*

Gently sloping and moderately sloping, somewhat excessively drained sands in the valleys

The soils in this association are very deep. They formed in wind-modified stream deposits of mixed origin. Slopes are 2 to 9 percent. Elevation ranges from 10 to 150 feet. The average annual rainfall is 12 to 14 inches. The average annual temperature is 59° F., and the frost-free season is 260 to 300 days.

This association makes up about 2 percent of the county. It is about 85 percent Delhi soils. The rest is Rincon and Zamora soils.

Delhi soils are brown and yellowish-brown sand throughout.

These soils are used for almonds, vineyards, and some walnuts and apricots. The wildlife is upland game that requires supplemental food and cover.

5. *Clear Lake-Cropley association*

Nearly level to gently sloping, poorly drained and moderately well drained clays on valley fill and in coastal valley basins

The soils in this association are very deep. They formed in alluvium mainly from sedimentary rocks. Slopes are 0 to 5 percent. Elevation ranges from 5 to 1,500 feet. The average annual rainfall is 14 to 25 inches. The average annual temperature is 59° F., and the frost-free season is 260 to 300 days.

This association makes up about 10 percent of the county. It consists of about 50 percent Clear Lake soils and 20 percent Cropley soils. About 10 percent is Botella soils, and 10 percent is Conejo soils. The rest is Omni, Pescadero, and Garretson soils.

Clear Lake soils have poor natural drainage, but drainage has been altered by stream cutting and the water table is below a depth of 60 inches in most places. These soils have a surface layer of very dark gray clay. The substratum is mottled very dark grayish-brown and grayish-brown clay.

Cropley soils are moderately well drained. They have a surface layer of dark-gray clay. Below that is dark grayish-brown and dark-brown clay. The substratum is yellowish-brown and very pale brown heavy clay loam.

These soils are used mainly for urban development and related uses. Some areas are used for dryfarmed

grain (fig. 1), hay, and dryfarmed walnuts. Where the soils are not cultivated, the vegetation is annual grasses and forbs. The wildlife is mainly upland game that requires supplemental feed and cover.

6. Marcuse-Solano-Pescadero association

Nearly level, very poorly drained to somewhat poorly drained clays, loams, and clay loams on rims of basins

The soils in this association are very deep. They formed in alluvium from sedimentary rock. Slopes are 0 to 2 percent. Elevation ranges from near sea level to 150 feet. The average annual rainfall is 10 to 19 inches. The average annual temperature is 60° F., and the frost-free season is 250 to 300 days.

This association makes up 3 percent of the county. It consists of about 50 percent Marcuse soils, 20 percent Solano soils, and 15 percent Pescadero soils. The rest is San Ysidro, Sacramento, and Rincon soils and a few areas of Linne soils.

Marcuse soils are poorly drained and very poorly drained. They have a surface layer of faintly mottled grayish-brown, dark grayish-brown, and light olive-brown clay. The subsoil is mottled dark-gray, dark grayish-brown, brown and olive-brown clay. The substratum is mottled dark grayish-brown, brown, and grayish-brown clay.

Solano soils are somewhat poorly drained. The upper part of the surface layer is mixed grayish-brown and gray loam about 3 inches thick. The lower part is mottled grayish-brown and very dark grayish-brown clay loam. The subsoil is grayish-brown and brown clay loam and silty clay loam. The substratum is pale-brown clay loam.

Pescadero soils are poorly drained. They have a surface layer of mixed light-gray, gray, and very dark gray clay loam. The subsoil is black clay in the upper part and mottled dark-gray, grayish-brown, gray, and light yellowish-brown clay in the lower part. The substratum is olive-gray and pale-olive sandy clay loam.

These soils are used for irrigated pasture, some sugar beets and milo, and dryland pasture. Where they are not cultivated, the vegetation is annual grasses, saltbush, pickleweed, and meadow barley. The wildlife is either upland game or waterfowl, depending on the type of food and cover.

Nearly Level, Poorly Drained and Very Poorly Drained Soils on the Delta, Flood Plains, and Saltwater Marshes and Tidal Flats

These soils are clay loam, muck, silty clay, and clay. They formed in mixed mineral alluvium or from remains of hydrophytic plants. Slopes are less than 2 percent.

***Figure 1.*—The Clear Lake soils in the foreground are used for small grain. Diablo soils are in the background.**

Elevation ranges from 15 feet below sea level to 100 feet above sea level. The average annual precipitation is 12 to 22 inches. The average annual temperature is 59° to 60° F, and the frost-free season is 250 to 310 days. Most of the soils on the delta are intensively cultivated. Vegetation on the saltwater marshes and tidal flats is pickleweed, saltgrass, and sedges.

The three soil associations in this group make up 10 percent of the county.

7. Rindge-Kingile association

Nearly level, very poorly drained mucks on the delta

The soils in this association are more than 60 inches deep. They formed in remains of hydrophytic plants and fine-textured mineral deposits. Slopes are less than 2 percent. Elevation ranges from 5 to 15 feet below sea level. The average annual precipitation is 12 to 16 inches. The average annual temperature is 59° to 60° F, and the frost-free season is 250 to 310 days.

This association makes up about 6 percent of the county. It consists of about 40 percent Rindge soils and 20 percent Kingile soils. The rest is Piper, Ryde, Egbert, Merritt, and Venice soils.

Rindge soils have a surface layer of very dark brown muck. The layer below that is very dark gray muck, and it is underlain by black muck.

Kingile soils have a surface layer of black muck. Below that is very dark brown muck that is underlain by very dark gray and dark-gray silty clay.

Most of the acreage is intensively cultivated. The soils are used for irrigated field corn, tomatoes, and asparagus. The wildlife is upland game or waterfowl, depending on the type of food and cover provided. Many areas are flooded specifically for waterfowl in the fall and early in winter.

8. Sacramento-Omni association

Nearly level, poorly drained and very poorly drained clays and clay loams on the delta and on flood plains

The soils in this association are very deep. They formed in mixed alluvium. Slopes are less than 2 percent. Elevation ranges from near sea level to 100 feet. The average annual rainfall is 12 to 16 inches. The average annual temperature is 59° F., and the frost-free season is 260 to 300 days.

This association makes up about 2 percent of the county. It consists of about 55 percent Sacramento soils and 40 percent Omni soils. The rest is Marcuse soils.

The Sacramento soils are poorly drained and very poorly drained. They have a thick surface layer of very dark gray clay that is mottled below a depth of 9 inches. The underlying material is mottled gray and olive-brown clay.

Omni soils are poorly drained. The upper part of the surface layer is grayish-brown clay loam about 8 inches thick. The lower part is gray clay. The substratum is mottled gray, grayish-brown, and dark grayish-brown, stratified clay, sandy clay loam, clay loam, and loamy sand.

Sacramento soils are used for field corn, tomatoes, sugar beets, milo, and some irrigated pasture. Omni soils are used for dryland pasture, some barley, and industrial uses. The wildlife is either upland game or waterfowl, depending on the type of supplemental food and cover provided.

9. Joice-Reyes association

Nearly level, very poorly drained, saline mucks and silty clays on saltwater marshes and tidal flats

The soils in this association are very deep. They formed in remains of hydrophytic plants and fine-textured mineral alluvium from mixed rock. Slopes are less than 1 percent. Elevation ranges from sea level to 5 feet below sea level. The average annual rainfall is 12 to 22 inches. The average annual temperature is 59° to 60° F., and the frost-free season is 260 to 300 days.

This association makes up less than 2 percent of the county. It consists of 60 percent Joice soils and 35 percent Reyes soils. The rest is Marcuse soils.

Joice soils have a surface layer of dark-brown muck. The layers below that are black and very dark brown muck. The underlying material is dark grayish-brown muck that has a high content of polysulphides.

Reyes soils have a surface layer of very dark grayish-brown silty clay. The subsoil is dark-gray silty clay, and the substratum is black silty clay.

These soils are used for saltgrass pasture, wildlife, and recreation. Vegetation is pickleweed, saltgrass, and some sedges. A few areas are used for industrial development. The wildlife is waterfowl.

Nearly Level to Very Steep, Moderately Well Drained to Excessively Drained Soils on Terraces and Mountainous Uplands

These soils range from loams to clays. They formed mainly in weakly consolidated old alluvial sediments and in material weathered from interbedded sedimentary rock and some basic and ultrabasic igneous rock. Slopes are 0 to 75 percent.

Elevation ranges from 10 to 3,849 feet. The average annual rainfall is 12 to 25 inches. The average annual temperature is 56° to 59° F., and the frost-free season is 250 to 300 days. Vegetation is mostly annual grasses and forbs, but some areas have thick stands of oak, laurel, and poison-oak. A few areas have thick stands of chaparral.

The five soil associations in this group make up 64 percent of the county.

10. Tierra-Antioch-Perkins association

Nearly level to moderately steep, moderately well drained and well drained loams and clay loams that formed in old alluvium on terraces

Most of the soils in this association are shallow to a subsoil that is dense and very slowly permeable. They formed in old, mainly weakly consolidated alluvium from mixed sources. Slopes are 0 to 30 percent. Elevation ranges from 10 to 1,200 feet. The average annual rainfall is 12 to 25 inches. The average annual temperture is 59° F., and the frost-free season is 260 to 300 days.

This association makes up about 4 percent of the county. It consists of about 50 percent Tierra soils, 20 percent Antioch soils, and 20 percent Perkins soils. The rest is Kimball soils.

Tierra soils are moderately well drained. They have a surface layer of dark-gray and gray loam and clay loam. The upper part of the subsoil is grayish-brown clay. The lower part is light yellowish-brown silty clay loam that extends to a depth of more than 60 inches.

Antioch soils are moderately well drained. They have a surface layer of dark grayish-brown and dark-brown loam. The subsurface layer is mottled gray loam. The subsoil is mottled brown clay, and the substratum is yellowish-brown clay loam.

Perkins soils are well drained and very deep. They have a surface layer of reddish-brown and reddish-gray gravelly heavy loam. The subsoil is weak-red gravelly clay loam. The substratum is reddish-brown, weakly consolidated gravelly clay loam.

These soils are used mainly for range and for buildings and related urban uses. Where the soils are not cultivated, the vegetation is annual grasses, forbs, and scattered oaks. The wildlife is mainly upland game, depending on the type of food and cover provided.

11. Altamont-Diablo-Fontana association

Strongly sloping to very steep, well-drained clays and silty clay loams that formed in material weathered from soft, fine-grained sandstone and shale on uplands

The soils in this association are moderately deep to deep. They formed in material weathered from soft, fine-grained sandstone and shale. Slopes are 9 to 75 percent. Elevation ranges from 400 to 1,500 feet. The average annual rainfall is 12 to 20 inches. The average annual temperature is 59° to 60° F., and the frost-free season is 260 to 300 days.

This association makes up about 26 percent of the county. It is about 50 percent Altamont soils, 20 percent Diablo soils, and 20 percent Fontana soils. The rest is Linne, Alo, Millsholm, and Gaviota soils.

Altamont soils have a surface layer of dark grayish-brown clay underlain by grayish-brown silty clay. Shale is at a depth of 40 to 60 inches.

Diablo soils have a surface layer of clay. It is dark gray in the upper part and mixed dark gray and light gray in the lower part. Below that is mixed light-gray, dark-gray, and olive-gray clay and silty clay. Soft shale is at a depth of 40 to 60 inches.

Fontana soils have a surface layer of dark grayish-brown silty clay loam. The substratum is yellowish-brown silty clay loam that is underlain at a depth of 20 to 36 inches by fine-grained sandstone.

These soils are used for range and some dryfarmed grain and volunteer hay. Where the soils are not cultivated, the vegetation is annual grasses, forbs, and scattered oaks. The wildlife is upland game that requires supplemental food and cover.

12. Los Osos-Millsholm-Los Gatos association

Moderately steep to very steep, well-drained clay loams and loams that formed in material weathered from interbedded sedimentary rock on uplands

The soils in this association are shallow to moderately deep. They formed in material weathered from interbedded sedimentary rock. Slopes range from 15 to 75 percent. Elevation ranges from 100 to 2,500 feet. The average annual rainfall is 14 to 25 inches. The average annual temperature is 56° to 59° F., and the frost-free season is 250 to 300 days.

This association makes up about 28 percent of the county. It consists of about 35 percent Los Osos soils, 20 percent Millsholm soils, and 15 percent Los Gatos soils. The rest is Lodo, Dibble, Alo, Sehorn, and Briones soils.

Los Osos soils have a surface layer of gray clay loam and a subsoil of gray and grayish-brown clay. Soft, fine-grained sandstone is at a depth of 24 to 40 inches.

Millsholm soils have a surface layer and subsoil of grayish-brown loam that are underlain by fine-grained sandstone at a depth of 10 to 20 inches.

Los Gatos soils have a surface layer of brown heavy loam. The subsoil is mainly reddish-brown clay loam, and it is underlain by sandstone at a depth of 20 to 40 inches.

These soils are used for range, wildlife habitat, watershed, and homesites and related uses. The vegetation is grass and oak, and thick stands of laurel, oak, and poison-oak are on many north-facing slopes. The wildlife is mainly deer.

13. Gilroy-Vallecitos association

Moderately steep to very steep, well-drained clay loams and loams that formed in material weathered from basic igneous rock and metasedimentary rock on uplands

The soils in this association are shallow to moderately deep. They formed in material weathered from basic igneous rock and metasedimentary rock. Slopes are 15 to 75 percent. Elevation ranges from 500 to 3,000 feet. The average annual rainfall is 15 to 25 inches. The average annual temperature is 57° to 58° F., and the frost-free season is 240 to 300 days.

This association makes up about 2 percent of the county. It consists of about 50 percent Gilroy soils and 35 percent Vallecitos soils. The rest is Los Gatos, Millsholm, Los Osos, and Felton soils.

Gilroy soils have a surface layer of reddish-brown light clay loam. The upper part of the subsoil is reddish-brown clay loam, and the lower part is reddish-brown very gravelly loam. Basic igneous rock is at a depth of 20 to 40 inches.

Vallecitos soils have a surface layer that is brown loam in the upper part and reddish-brown clay loam in the lower part. The subsoil is reddish-brown light clay. Shattered metasedimentary rock is at a depth of 12 to 20 inches.

These soils are used for range, wildlife habitat, and watershed. Vegetation is oak and grass and some digger pine. The wildlife is mainly deer.

14. Rock outcrop-Xerorthents association

Steep to very steep areas of rock outcrop and excessively drained, very shallow, loamy soils that formed

in material weathered from sedimentary rock and basic igneous rock on uplands

This association is 50 to 75 percent rock outcrops, and the rest is very shallow loamy soils. Slopes are 30 to 75 percent. Elevation ranges from 1,000 to 3,849 feet. The average annual rainfall is 20 to 25 inches. The average annual temperature is 59° F., and the frost-free season is 240 to 280 days.

This association makes up about 4 percent of the county. It is about 85 percent Rock outcrop-Xerorthents association. The rest is Millsholm, Gaviota, and Vallecitos soils.

These soils are used for wildlife habitat and watershed. Vegetation in some areas is thick stands of chamise and yerba santa. In other areas it is oak, digger pine, and poison-oak with an understudy of mouse barley. The wildlife is mainly deer.

Descriptions of the Soils

This section describes the soil series and mapping units in Contra Costa County. Each soil series is described in detail, and then each mapping unit in that series is described briefly. Unless otherwise stated, it is assumed that facts given for a soil series hold true for each mapping unit in that series. Thus, to get full information about any mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, describing the sequence of layers from the surface downward to rock or other underlying material. Each series includes two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. The profile described in the series is representative for mapping units in that series. If a given mapping unit has a profile different from the one described for the series, the differences are mentioned in describing the mapping unit, or they are apparent from the name of the mapping unit. Color terms used in the profile are for dry soil unless otherwise stated.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Urban land, for example, does not belong to a soil series, but nevertheless is listed in alphabetic order along with the soil series.

Preceding the name of each mapping unit is a symbol which identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit and range site in which the mapping unit has been placed. The page for the description of each capability unit and range site can be found in the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*8*).[1]

The soil maps of Contra Costa County will not necessarily match those in the soil survey of the Alameda Area, completed in 1961. New criteria for soil series and their interpretations have been developed which change some delineations or soil series names.

Alo Series

The Alo series consists of well-drained soils underlain by soft sandstone and shale. These soils are on uplands. Slopes are 15 to 75 percent. Elevation ranges from 500 to 1,500 feet. The average annual air temperature is 59° F., and the frost-free season is 260 to 300 days. The average annual rainfall is 14 to 25 inches. These soils are moist from December to May and are dry from June to mid-October in most years. Vegetation is annual grasses, forbs, and scattered oaks.

In a representative profile the surface layer is dark-gray, slightly acid clay. It is underlain at a depth of about 24 inches by soft, fine-grained sandstone.

Permeability is slow, and the available water capacity is 3.5 to 7 inches. Roots can penetrate to a depth of 20 to 40 inches.

Alo soils are used mainly for range. Some areas are used for homesites, and a few small areas are used for dryland grain.

Representative profile of Alo clay, 30 to 50 percent slopes, on a grassy sidehill south of Stone Valley Road in NW¼NW¼SW¼ sec. 16, T. 1 S., R. 1 W.

Ap—0 to 6 inches, dark-gray (10YR 4/1) clay, very dark grayish brown (10YR 3/2) when moist; moderate, medium and coarse, subangular blocky structure; very hard, firm, sticky and very plastic; many very fine roots; common, very fine and few, fine, random, tubular pores; slightly acid; clear, smooth boundary.

A1—6 to 24 inches, dark-gray (10YR 4/1) clay, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure parting to weak, medium, angular blocky; very hard, firm, sticky and very plastic; many very fine and few fine roots; common, very fine, tubular, exped pores; few thin clay films on ped faces; many intersecting slickensides; slightly acid; abrupt, wavy boundary.

Cr—24 to 30 inches, light yellowish-brown (10YR 6/4) sandstone; slightly acid.

The A horizon is gray, dark gray, grayish brown, or dark grayish brown in a hue of 10YR or 2.5Y. The moist value is 2. The A horizon is typically slightly acid, but in some places it is neutral or slightly calcareous in the lower part.

In areas where the soils are not cultivated, cracks ¼ inch to ½ inch wide extend from the surface into the Cr horizon after long dry periods. In these areas, coarse prismatic structure extends throughout the profile.

Generally the soil is free of coarse fragments, but in places it contains as much as 5 percent well-rounded pebbles, by volume. Depth to soft, fine-grained sandstone and shale ranges from 20 to 40 inches.

AaE—Alo clay, 15 to 30 percent slopes. This soil is commonly on smooth hilly uplands, but a few small areas are on rolling hills. It has a profile similar to the

[1] Italic numbers in parentheses refer to Literature Cited, p. 21.

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil	Area	Extent	Soil	Area	Extent
	Acres	*Percent*		*Acres*	*Percent*
Alo clay, 15 to 30 percent slopes	2,750	0.6	Linne clay loam, 15 to 30 percent slopes	1,000	0.2
Alo clay, 30 to 50 percent slopes	4,085	.9	Lodo clay loam, 9 to 30 percent slopes	3,860	.8
Alo clay, 50 to 75 percent slopes	635	.1	Lodo clay loam, 30 to 50 percent slopes	7,155	1.5
Altamont clay, 9 to 15 percent slopes	4,410	.9	Lodo clay loam, 50 to 75 percent slopes	2,995	.6
Altamont clay, 15 to 30 percent slopes	16,985	3.6	Lodo-Rock outcrop complex	1,405	.3
Altamont-Fontana complex, 30 to 50 percent slopes	27,475	5.9	Los Gatos loam, 15 to 30 percent slopes	715	.2
			Los Gatos loam, 30 to 50 percent slopes	18,695	3.4
Altamont-Fontana complex, 50 to 75 percent slopes	4,990	1.1	Los Gatos loam, 50 to 75 percent slopes	4,840	1.0
			Los Osos clay loam, 15 to 30 percent slopes	10,120	2.2
Antioch loam, 0 to 2 percent slopes	1,205	.3	Los Osos clay loam, 30 to 50 percent slopes	33,610	7.2
Antioch loam, 2 to 9 percent slopes	2,940	.6	Los Osos clay loam, 50 to 75 percent slopes	1,460	.3
Botella clay loam, 0 to 2 percent slopes	3,555	.8	Los Osos-Los Gatos complex	4,145	.9
Botella clay loam, 2 to 9 percent slopes	1,645	.3	Los Robles clay loam	1,845	.4
Brentwood clay loam	8,100	1.7	Marcuse sand	290	.1
Brentwood clay loam, wet	1,525	.3	Marcuse clay	4,535	1.0
Briones loamy sand, 5 to 30 percent slopes	2,635	.6	Marcuse clay, strongly alkali	600	.2
Briones loamy sand, 15 to 30 percent slopes, eroded	395	.1	Merritt loam	685	.1
			Millsholm loam, 15 to 30 percent slopes	850	.2
Briones loamy sand, 30 to 50 percent slopes	780	.2	Millsholm loam, 30 to 50 percent slopes	10,720	2.3
			Millsholm loam, 50 to 75 percent slopes	11,960	2.5
Briones loamy sand, 30 to 50 percent slopes, eroded	1,040	.2	Omni clay loam	945	.2
Briones fine sandy loam, 2 to 5 percent slopes	230	(1)	Omni silty clay	1,425	.3
Capay clay, 0 to 2 percent slopes	10,630	2.3	Perkins gravelly loam, 2 to 9 percent slopes	1,340	.3
Capay clay, 2 to 9 percent slopes	3,175	.7	Perkins gravelly loam, 9 to 15 percent slopes	300	.1
Capay clay, wet, 0 to 2 percent slopes	4,805	1.0	Pescadero clay loam	1,990	.4
Clear Lake clay	21,373	4.6	Pescadero clay loam, strongly alkali	705	.2
Conejo clay loam, 0 to 2 percent slopes	5,070	1.1	Piper sand	470	.1
Conejo clay loam, 2 to 5 percent slopes	560	.1	Piper loamy sand	2,710	.6
Conejo clay loam, clay substratum, 0 to 2 percent slopes	884	.2	Piper fine sandy loam	2,630	.6
			Positas loam, 0 to 2 percent slopes	1,310	.3
Cropley clay, 2 to 5 percent slopes	8,145	1.7	Positas loam, 2 to 9 percent slopes	760	.2
Cut and fill land-Diablo complex, 9 to 30 percent slopes	1,250	.3	Quarry	590	.2
			Reyes silty clay	2,410	.5
Cut and fill land-Los Osos complex, 9 to 30 percent slopes	3,595	.8	Rincon clay loam, 0 to 2 percent slopes	6,655	1.4
			Rincon clay loam, 2 to 9 percent slopes	6,965	1.5
Cut and fill land-Millsholm complex, 9 to 30 percent slopes	1,860	.4	Rincon clay loam, 9 to 15 percent slopes	875	.2
			Rincon clay loam, wet, 0 to 2 percent slopes	590	.1
Cut and fill land-Millsholm complex, 30 to 50 percent slopes	490	.1	Rindge muck	10,715	2.3
			Rock outcrop-Xerorthents association	14,610	3.1
Delhi sand, 2 to 9 percent slopes	8,510	1.8	Ryde silt loam	2,680	.6
Diablo clay, 9 to 15 percent slopes	2,975	.6	Sacramento clay	3,730	.8
Diablo clay, 15 to 30 percent slopes	16,305	3.5	Sacramento clay, alkali	1,470	.3
Diablo clay, 30 to 50 percent slopes	15,145	3.2	San Ysidro loam	2,525	.5
Dibble silty clay loam, 15 to 30 percent slopes	1,135	.3	Sehorn clay, 15 to 30 percent slopes	1,005	.2
Dibble silty clay loam, 30 to 50 percent slopes	9,210	2.0	Sehorn clay, 30 to 50 percent slopes	3,015	.6
Egbert mucky clay loam	1,360	.3	Sehorn clay, 50 to 75 percent slopes	800	.2
Felton loam, 50 to 75 percent slopes	845	.2	Shima muck	2,995	.6
Fluvaquents	1,000	.2	Solano loam	1,870	.4
Fontana-Altamont complex	1,165	.3	Solano loam, strongly alkali	725	.2
Garretson loam, 0 to 2 percent slopes	855	.2	Sorrento silty clay loam	2,305	.5
Garretson loam, 2 to 5 percent slopes	690	.2	Sorrento silty clay loam, sand substratum	365	.1
Gaviota sandy loam, 15 to 30 percent slopes	545	.1	Sycamore silty clay loam	2,495	.5
Gaviota sandy loam, 30 to 50 percent slopes	2,985	.6	Sycamore silty clay loam, clay substratum	800	.2
Gaviota sandy loam, 50 to 75 percent slopes	1,735	.4	Tierra loam, 2 to 9 percent slopes	3,666	.8
Gilroy clay loam, 15 to 30 percent slopes	300	.1	Tierra loam, 9 to 15 percent slopes	4,980	1.1
Gilroy clay loam, 30 to 50 percent slopes	3,005	.6	Tierra loam, 15 to 30 percent slopes	2,520	.5
Gilroy clay loam, 50 to 75 percent slopes	2,360	.5	Urban land	7,952	1.7
Joice muck	6,260	1.3	Vallecitos loam, 30 to 50 percent slopes	3,610	.8
Kimball gravelly clay loam, 2 to 9 percent slopes	1,035	.2	Venice muck	455	.1
			Webile muck	1,035	.2
Kimball gravelly clay loam, 9 to 30 percent slopes	645	.2	Zamora silty clay loam, 0 to 2 percent slopes	5,415	1.2
			Zamora silty clay loam, 2 to 5 percent slopes	970	.2
Kingile muck	4,655	1.0			
Laugenour loam	520	.1	Total	468,650	100.0
Linne clay loam, 5 to 15 percent slopes	1,330	.3			

[1] Less than 0.1 percent.

one described as representative of the series, but the depth to soft shale and sandstone is 30 to 40 inches.

Included with this soil in mapping are areas of Diablo clay that make up about 10 percent of the mapping unit. This soil is along the lower part of the slopes. Also included are areas of Cropley clay along toe slopes that make up 3 percent. A few areas of Clear Lake clay in concave drainageways make up 2 percent.

Runoff is medium, and the hazard of erosion is moderate where the soil is tilled and exposed. Roots can penetrate to a depth of 30 to 40 inches. The available water capacity is 5 to 7 inches.

This soil is used mainly for range. A few areas are used for dryland grain and grain hay, and some areas are used for homesites. Capability unit IVe–5(15); Clayey range site.

AaF—Alo clay, 30 to 50 percent slopes. This steep soil is on hills. It has the profile described as representative of the series. Depth to soft sandstone and shale is 20 to 36 inches.

Included with this soil in mapping are areas of Altamont clay that make up about 3 percent of the mapping unit, areas of Fontana silty clay loam that make up 3 percent, areas of Lodo clay loam that make up 2 percent, areas of Los Osos clay loam that make up 4 percent, and areas of Sehorn clay that make up 3 percent.

Runoff is medium to rapid, and the hazard of erosion is moderate to bigh where the soil is bare. Roots can penetrate to a depth of 20 to 36 inches. The available water capacity is 3.5 to 6 inches.

This soil is used mainly for range. Some areas are used for homesites. Capability unit VIe–1 (15); Clayey range site, steep.

AaG—Alo clay, 50 to 75 percent slopes. This very steep soil is on hills. It has a profile similar to the one described as representative of the series. Depth to soft sandstone and shale is 20 to 30 inches.

Included with this soil in mapping are areas of Lodo clay loam that make up about 5 percent of the mapping unit and areas of Millsholm loam that make up 5 percent. A few areas of severely eroded soils that are less than 20 inches deep to sandstone and shale are also included.

Runoff is rapid, and the hazard of erosion is high where the soil is bare. The available water capacity is 3.5 to 5 inches. Roots can penetrate to a depth of 20 to 30 inches.

This soil is used for range. Capability unit VIIe–1(15); Clayey range site, very steep.

Altamont Series

The Altamont series consists of well-drained soils underlain by shale and soft, fine-grained sandstone. These soils are on foothills north and east of Mount Diablo. Slopes are 9 to 75 percent. Elevation ranges from 400 to 1,500 feet. The average annual air temperature is 59° F., and the frost-free season is 260 to 300 days. The average annual rainfall is 12 to 16 inches. These soils are moist to a depth of 24 inches from December to April and are dry from May to November in most years. Vegetation is annual grasses, forbs, and scattered oaks.

In a representative profile the surface layer is dark grayish-brown, neutral to moderately alkaline clay about 26 inches thick. The layer below that is dark grayish-brown and brown, calcareous clay about 13 inches thick. The substratum is grayish-brown, calcareous silty clay. Shale is at a depth of 48 inches.

Permeability is slow, and the available water capacity is 6.5 to 10 inches. Roots can penetrate to a depth of 40 to 60 inches.

Altamont soils are used for range, dryland grain, and volunteer hay.

Representative profile of Altamont clay, 15 to 30 percent slopes, on a smooth, rounded hill 7 miles south of Brentwood in SE¼SE¼N½ sec. 18, T. 1 S., R. 3 E.

A11—0 to 14 inches, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) when moist; strong, very coarse, prismatic structure parting to moderate, coarse, angular blocky; extremely hard, very firm, sticky and plastic; many very fine roots; common, very fine, tubular pores; neutral; gradual, wavy boundary.

A12—14 to 26 inches, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) when moist; strong, very coarse, prismatic structure parting to moderate, coarse, angular blocky; extremely hard, very firm, sticky and very plastic; many very fine exped roots; common, very fine, tubular pores; many intersecting slickensides; some black carbonaceous spots; moderately alkaline; gradual, wavy boundary.

ACca—26 to 39 inches, dark grayish-brown (10YR 4/2) and brown (10YR 4/3) clay, dark brown (10YR 3/3) when moist; moderate, very coarse, prismatic structure parting to weak, coarse, angular blocky; extremely hard, firm, sticky and very plastic; common very fine roots; few, very fine, tubular pores; many intersecting slickensides; moderately alkaline; slightly calcareous; disseminated lime and filaments and soft bodies of lime; gradual, wavy boundary.

C1ca—39 to 48 inches, grayish-brown (10YR 5/2) silty clay, dark brown (10YR 3/3) when moist; fragments of weathered shale; moderate, medium, subangular blocky structure; very hard, firm, sticky and plastic; very few very fine roots; few fine pores; moderately alkaline; slightly calcareous; gradual, wavy boundary.

C2r—48 to 60 inches, light grayish-brown shale.

The A horizon is 20 to 30 inches thick. It is dark brown, grayish brown, or dark grayish brown in a hue of 10YR. Moist values are less than 3.5.

Cracks ¼ to 2 inches wide extend from the surface into the upper part of the C horizon after long dry periods. The cracks form a coarse or very coarse prismatic structure. Depth to lime ranges from 20 to 30 inches. The lower part of the A horizon or the upper part of the C horizon has a slight to distinct accumulation of secondary lime.

The ACca horizon is 12 to 16 inches thick. The C1ca horizon is 8 to 14 inches thick. It is silty clay loam or silty clay and contains as much as 5 percent gravel, by volume, where the soils formed in soft conglomerates. Depth to sedimentary rock ranges from 40 to 60 inches.

AbD—Altamont clay, 9 to 15 percent slopes. This soil is on smooth, rolling hills. Included with it in mapping are areas of Capay clay that make up about 6 percent of the mapping unit and areas of Rincon clay loam that make up 4 percent. These soils are in small drainageways. Also included are areas of Fon-

tana silty clay loam that make up 4 percent and areas of Linne clay loam that make up 1 percent.

Runoff is slow to medium where the soil is tilled and exposed. The hazard of erosion is slight to moderate. It is slight in areas of range.

This soil is used mainly for range, dryland grain, and some volunteer hay. Capability unit IIIe–5(15); Clayey range site.

AbE—Altamont clay, 15 to 30 percent slopes. This soil is on rolling hills. It has the profile described as representative of the series.

Included with this soil in mapping are areas of Capay clay that make up about 5 percent of the mapping unit and areas of Rincon clay loam that make up 3 percent. These soils are along narrow drainageways and in depressions. Also included are areas of Fontana silty clay loam that make up 3 percent and areas of Linne clay loam that make up 2 percent. A few areas of highly calcareous silty clay loam underlain by sedimentary rock at a depth of 40 to 60 inches are also included.

Runoff is medium, and the hazard of erosion is moderate where the soil is bare.

This soil is used mainly for range and dryland grain or grain hay. Capability unit IVe–5(15); Clayey range site.

AcF—Altamont-Fontana complex, 30 to 50 percent slopes. This complex is on foothills in the eastern uplands of the county. It consists of about 50 percent Altamont clay and 35 percent Fontana silty clay loam. The remaining 15 percent is Millsholm loam, Lodo clay loam, Capay clay, and Rincon clay loam. The Fontana soil has the profile described as representative of the series.

Altamont soils are on the lower part of the slopes and on north-facing slopes. Fontana soils are on ridge crests and on south-facing slopes. Millsholm and Lodo soils are less than 20 inches deep to sandstone and shale. Capay and Rincon soils are in small drainageways and on toe slopes.

Where the soils are bare, runoff is medium to rapid and the hazard of erosion is moderate to high.

The soils in this complex are used mainly for range. A few areas are used for dryland small grain. Capability unit VIe–1(15); Clayey range site, steep.

AcG—Altamont-Fontana complex, 50 to 75 percent slopes. This complex is on foothills in the eastern part of the county. It consists of about 40 percent Altamont clay, 40 percent Fontana silty clay loam, and 15 percent Millsholm loam. The remaining 5 percent is Gaviota sandy loam and Briones loamy sand. Altamont clay has slopes of 50 to 60 percent. Fontana silty clay loam has slopes of 50 to 75 percent and is on south-facing slopes.

Where the soils are bare, runoff is rapid and the hazard of erosion is high.

The soils in this complex are used for range. Capability unit VIIe–1(15); Clayey range site, very steep.

Antioch Series

The Antioch series consists of moderately well drained soils underlain by old mixed alluvium. These soils are on old terraces and fans. Slopes are 0 to 9 percent. Elevation ranges from 10 to 300 feet. The average annual temperature is 59° F., and the frost-free season is 260 to 280 days. The average annual rainfall is 14 to 18 inches. These soils are dry from May or early in June to late in October in most years. Vegetation is annual grasses and forbs.

In a representative profile the surface layer is dark grayish-brown and dark-brown, strongly acid or medium acid loam about 14 inches thick. The subsurface layer is mottled, gray, medium acid heavy loam about 3 inches thick. The subsoil is mottled, brown clay about 19 inches thick. It is slightly acid in the upper part and becomes moderately alkaline as depth increases. The substratum is yellowish-brown, calcareous clay loam that extends to a depth of more than 60 inches.

Permeability is very slow in the subsoil. The available water capacity is 3.5 to 5 inches. The depth to which roots can penetrate is limited to 12 to 20 inches by the clay subsoil. Some water available to plants perches above the subsoil for short periods.

Antioch soils are used mainly for range. A few areas are used for irrigated pasture and homesites.

Representative profile of Antioch loam, 2 to 9 percent slopes, on a gently sloping terrace used for range near Port Chicago in SW¼SE¼ sec. 5, T. 2 N., R. 1 W.

A1p—0 to 4 inches, dark grayish-brown (10YR 4/2) loam, dark brown (10YR 3/3) when moist; massive; hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common, very fine and fine, tubular pores; strongly acid; abrupt, smooth boundary.

A12—4 to 14 inches, dark-brown (10YR 3/3) loam, very dark grayish brown (10YR 3/2) when moist; massive; hard, firm, slightly sticky and slightly plastic; few fine and very fine roots; few, fine, tubular pores; medium acid; clear, wavy boundary.

A2—14 to 17 inches, gray (10YR 6/1) heavy loam, dark brown (10YR 3/2) when moist; common, fine, distinct, strong-brown (7.5YR 5.8) mottles, dark yellowish brown (10YR 4/4) when moist; massive; very hard, firm, slightly sticky and slightly plastic; few very fine roots that spread out on the boundary and form a thin mat; common, very fine, tubular pores; medium acid; abrupt, wavy boundary.

B21t—17 to 29 inches, brown (10YR 4/3) clay, dark brown (10YR 3/3) when moist; many, fine, distinct, dark yellowish-brown (10YR 4/4) mottles; moderate, coarse, columnar structure; gray (10YR 6/1) coatings on top of peds which follow down cleavage planes 1 to 2 inches; extremely hard, extremely firm, very sticky and very plastic; very few very fine roots; few very fine pores; thick continuous clay films on ped faces and in pores; slightly acid; diffuse, wavy boundary.

B22t—29 to 36 inches, brown (10YR 4/3) clay, dark yellowish brown (10YR 3/4) when moist; many, fine, distinct, dark yellowish-brown (10YR 4/4) mottles; moderate, coarse, prismatic structure; extremely hard, extremely firm, very sticky and very plastic; very few very fine roots; few, fine, tubular pores; thick continuous clay films in pores; moderately alkaline; distinct, wavy boundary.

C—36 to 60 inches, yellowish-brown (10YR 5/4) clay loam, dark yellowish brown (10YR 4/4) when moist; massive; extremely hard, very firm, sticky and plastic; very few very fine roots; common, very fine and fine, tubular pores; few thin clay films; moderately alkaline; strongly calcareous; lime is disseminated, in small soft masses, and in seams.

The A1 horizon is 11 to 17 inches thick. It is dark grayish brown or dark brown in a hue of 10YR. It is strongly acid or medium acid loam or light clay loam. The A2 horizon is 2 to 5 inches thick. It is gray, light gray, or light grayish brown.

The B2t horizon is 16 to 23 inches thick. It is brown or dark yellowish brown in hues of 10YR and 7.5YR. The structure is weak to moderate columnar or prismatic parting to moderate, medium or coarse, subangular blocky. The B22t horizon is mildly alkaline to strongly alkaline. It is underlain by a B3ca horizon of brown silty clay loam in some places.

The C horizon is loam, heavy loam, or clay loam. It is light yellowish brown, yellowish brown, or pale brown and is moderately alkaline or strongly alkaline.

AdA—Antioch loam, 0 to 2 percent slopes. This nearly level soil is on low terraces. Included with it in mapping are areas of Rincon clay loam that make up about 5 percent of the mapping unit. These areas are along channels of small streams. Also included are areas of Pescadero clay loam in concave drainageways that make up 3 percent. Scattered areas of Tierra loam that make up 4 percent are also included.

Runoff is slow. The hazard of erosion is slight where the soil is tilled and exposed.

This soil is used mainly for dryland pasture, small grain, and volunteer hay. Small areas are used for homesites. Capability unit IIIs–3(17); Claypan range site.

AdC—Antioch loam, 2 to 9 percent slopes. This gently sloping to moderately sloping soil is on terraces. Included in mapping are areas of Tierra loam that make up about 10 percent of the mapping unit and areas of Rincon clay loam that make up 5 percent. A few small areas of strongly sloping soils are also included.

Runoff is slow to medium. The hazard of erosion is slight to moderate where the soil is tilled and exposed.

This soil is used mainly for range. A few areas are used for homesites. Capability unit IVe–3(15); Claypan range site.

Botella Series

The Botella series consists of moderately well drained and well drained soils on alluvial fans and flood plains. These soils formed in alluvium from sedimentary rock. Slopes are 0 to 9 percent. Elevation ranges from 300 to 700 feet. The average annual temperature is 59° F., and the frost-free season is 260 to 290 days. The average annual rainfall is 15 to 25 inches. These soils are dry from June to mid-October and are moist from late in December to May in most years. Vegetation is annual grasses, forbs, and some oak and sycamore near creeks.

In a representative profile the surface layer is very dark gray, medium acid clay loam and silty clay loam about 8 inches thick. The subsoil is very dark gray, medium acid and slightly acid silty clay loam to a depth of 36 inches and faintly mottled, gray and very dark gray silty clay loam to a depth of 52 inches. The substratum is faintly mottled, grayish-brown and light brownish-gray, neutral silty clay loam that extends to a depth of more than 60 inches.

Permeability is moderately slow, and the available water capacity is 10 to 12 inches. Roots can penetrate to a depth of more than 60 inches.

Botella soils are used for homesites and for some dryland walnuts, pasture, and volunteer hay.

Representative profile of Botella clay loam, 0 to 2 percent slopes, on an alluvial fan used for walnuts. It is about 2,000 feet east of the junction of Norris Canyon Road and San Ramon road in SW¼SW¼NW¼ sec. 10, T. 2 S., R. 2 W. (projected).

A1p—0 to 3 inches, very dark gray (10YR 3/1) clay loam, black (10YR 2/1) when moist; moderate, medium and fine, subangular blocky structure; hard, friable, slightly sticky and plastic; many very fine roots; common, very fine, fine, and medium, tubular pores; medium acid; abrupt, smooth boundary.

A12—3 to 8 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; moderate, medium and fine, angular blocky structure; hard, friable, sticky and plastic; very few very fine and medium roots; many medium and common, very fine and fine, tubular pores; medium acid; gradual, wavy boundary.

B1t—8 to 23 inches, very dark gray (N 3/0) silty clay loam, black (N 2/0) when moist; moderate, medium and fine, angular blocky structure; hard, firm, sticky and plastic; few very fine and very few medium roots; very few, fine and medium, tubular pores; few thin clay films lining pores and on ped faces; medium acid; gradual, wavy boundary.

B2t—23 to 36 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; moderate, medium and fine, angular blocky structure; hard, firm, sticky and plastic; few very fine roots; common, very fine, tubular pores; many thin clay films lining pores and on ped faces; slightly acid; gradual, wavy boundary.

B3—36 to 52 inches, faintly mottled, gray and very dark gray (10YR 5/1 and 3/1) silty clay loam, dark grayish-brown and very dark grayish-brown (10YR 4/2 and 3/2) when moist; moderate, fine, angular blocky structure; hard, firm, sticky and plastic; very few very fine roots; common, very fine, tubular pores; few thin clay films lining pores and on ped faces; neutral; gradual, wavy boundary.

C—52 to 68 inches, faintly mottled, grayish-brown and light brownish-gray (10YR 5/2 and 6/2) silty clay loam, dark grayish-brown (10YR 4/2) when moist; weak, coarse, angular blocky structure; hard, friable, slightly sticky and slightly plastic; very few very fine roots; common, very fine, tubular pores; few thin clay films on ped faces and common thin clay glms lining pores; 1 to 2 inch gravel lens at a depth of 60 inches; neutral.

The A horizon is 7 to 12 inches thick. It is dark gray, very dark gray, or black. It is medium acid or slightly acid. The Ap horizon has medium or coarse, granular or moderate, fine or medium, subangular blocky structure. The A12 horizon has weak or moderate, subangular blocky or angular blocky structure.

The B1t horizon is 13 to 16 inches thick and is very dark gray or very dark grayish brown. Moist values are less than 2. In the B2t horizon clay films are thin or moderately thick and are few or common. Structure is weak or moderate, subangular blocky or angular blocky. Reaction is slightly acid or neutral. The B3 horizon is not mottled in some profiles.

The C horizon is grayish-brown or light brownish-gray silt loam, clay loam, or silty clay loam. In places it contains thin gravelly lenses.

BaA—Botella clay loam, 0 to 2 percent slopes. This nearly level soil is on alluvial fans and flood plains. It

has the profile described as representative of the series.

Included with this soil in mapping are more poorly drained, concave areas of Clear Lake clay. These areas make up about 3 percent of the mapping unit. Also included are areas of Conejo clay loam and Garretson loam that make up 6 percent. Areas of these soils are adjacent to small streams or drainageways. Areas of a soil that is similar to Botella soils but that has a clay subsoil are also included. These areas make up 5 percent.

This soil is moderately well drained. Runoff is very slow to slow, and the hazard of erosion is none to slight where the soil is tilled and exposed.

This soil is used for homesites and for some dryland walnuts and volunteer hay. Capability unit I(17).

BaC—Botella clay loam, 2 to 9 percent slopes. About 70 percent of this soil is gently sloping and is in small valleys (fig. 2), and 30 percent is moderately sloping and is in narrow upland valleys. Included with this soil in mapping are areas of Conejo clay loam adjacent to drainageways that make up about 7 percent of the mapping unit. Also included are areas of Tierra loam along the margins of valley fill and uplands that make up 5 percent.

This soil is well drained. Runoff is slow, and the hazard of erosion is slight where the soil is tilled and exposed.

This soil is used for dryland pasture, grain, and volunteer pasture. Capability unit IIe–1(17).

Brentwood Series

The Brentwood series consists of well drained and moderately well drained soils on valley fill. These soils formed in alluvium from sedimentary rock. Slopes are 0 to 2 percent. Elevation ranges from 40 to 200 feet. The average annual temperature is 60° F., and the frost-free season is 250 to 300 days. The average annual rainfall is 12 to 15 inches. These soils are dry from late in May to October and are moist from late in December to May in most years.

In a representative profile the surface layer is grayish-brown, moderately alkaline clay loam about 18 inches thick. The upper part of the subsoil is brown, moderately alkaline heavy clay loam about 15 inches thick. The lower part of the subsoil is yellowish-brown, moderately alkaline clay loam about 17 inches thick. The substratum is yellowish-brown silty clay loam that is calcareous and extends to a depth of more than 60 inches.

Permeability is moderately slow, and the available water capacity is 7 to 12 inches. Roots can penetrate to a depth of 40 to more than 60 inches.

Brentwood soils are used for irrigated walnuts, almonds, cherries, alfalfa, tomatoes, sugar beets, head lettuce, barley, and pasture.

Representative profile of Brentwood clay loam, in a nearly level orchard ½ mile south of Brentwood and 410 feet west of Walnut Boulevard in NE¼NE¼SE¼ sec. 24, T. 1 N., R. 2 E.

Ap—0 to 8 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) when moist; massive; hard, friable, sticky and plastic; common fine and very fine roots; many, fine and very fine, tubular and interstitial pores; moderately alkaline; clear, smooth boundary.

A12—8 to 18 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) when moist; massive; hard, friable, sticky and plastic; few fine and very fine roots; many, fine and very fine, tubular and interstitial pores; moderately alkaline; gradual, wavy boundary.

B2—18 to 33 inches, brown (10YR 4/3) heavy clay loam, dark brown (10YR 3/3) when moist; weak, medium, subangular blocky structure; hard, friable, sticky and plastic; few fine and very fine roots; many, fine and very fine, tubular pores; few thin clay films on ped faces and lining pores; moderately alkaline; clear, wavy boundary.

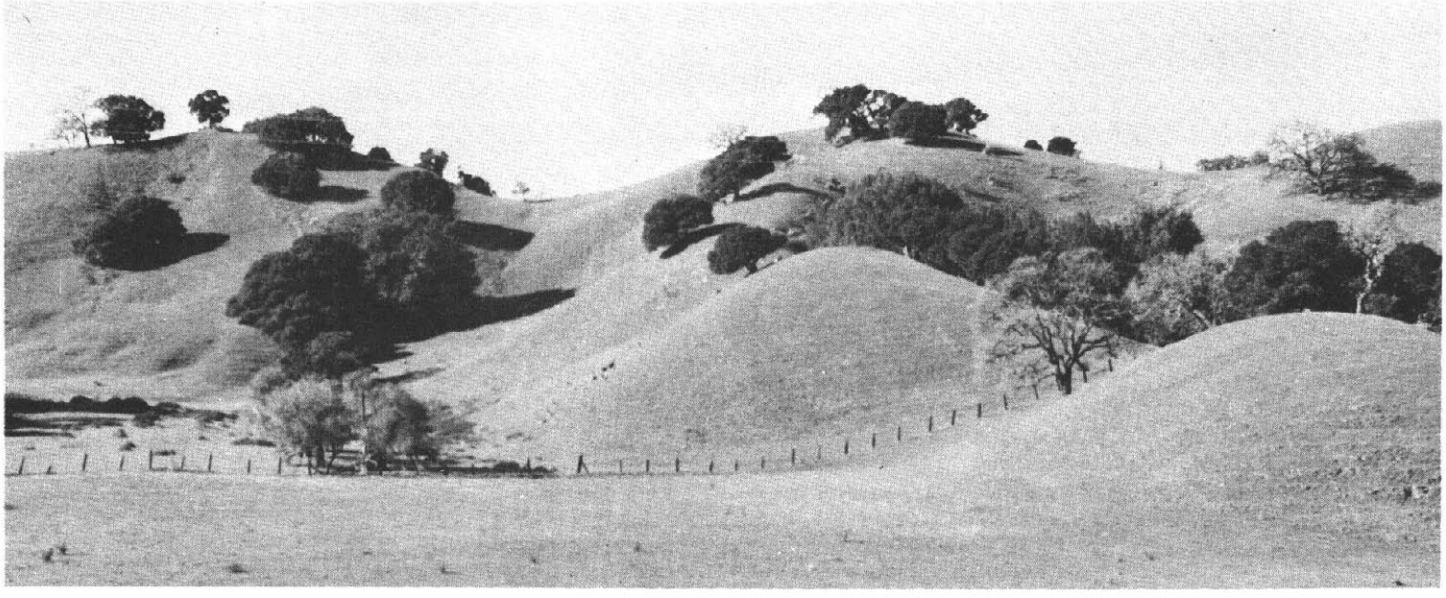

Figure 2.—**Typical landscape of Botella clay loam. Millsholm and Lodo soils are in background.**

B3—33 to 50 inches, yellowish-brown (10YR 5/4) clay loam, dark yellowish brown (10YR 3/4) when moist; massive; hard, very friable, sticky and plastic; few fine and very fine and very few medium roots; many, fine and very fine, tubular pores; few thin clay films lining pores; moderately alkaline; gradual, wavy boundary.

C—50 to 60 inches, yellowish-brown (10YR 5/4) silty clay loam, dark yellowish brown (10YR 3/4) when moist; massive; hard, very friable, sticky and slightly plastic; very few very fine roots; many, fine and very fine, tubular pores and many, fine, interstitial pores; moderately alkaline; lime is disseminated.

The A horizon is 14 to 20 inches thick. It is brown, grayish-brown, dark grayish-brown, or dark-brown clay loam or silty clay loam. It is neutral to moderately alkaline.

The B2 horizon is 12 to 18 inches thick. It is brown, grayish-brown, or dark grayish-brown heavy clay loam, heavy silty clay loam, or light clay. It is neutral to moderately alkaline. The B3 horizon is 14 to 20 inches thick. It is yellowish brown or brown and is calcareous in places.

The C horizon is yellowish-brown, light yellowish-brown, pale-brown, or brown loam, clay loam, or silty clay loam.

Bb—Brentwood clay loam. This nearly level soil is in valley fill. It has the profile described as representative of the series. Slopes are 0 to 2 percent.

Included with this soil in mapping are areas of Sorrento soils that make up about 10 percent of the mapping unit and areas of Rincon soils that make up 3 percent.

This soil is well drained. Runoff is slow, and there is no hazard of erosion where the soil is tilled and exposed. Roots can penetrate to a depth of more than 60 inches. The available water capacity is 10 to 12 inches.

This soil is used for all crops commonly grown on Brentwood soils. Capability unit I(17).

Bc—Brentwood clay loam, wet. This nearly level soil is on valley fill but is slightly lower on the landscape than Brentwood clay loam. It has a profile similar to the one described as representative of the series, but it has an intermittent water table at a depth of 40 to 50 inches. This water table is caused by lateral movement of irrigation water from the surrounding soils.

Included with this soil in mapping are areas of Sycamore silty clay loam that make up about 10 percent of the mapping unit.

This soil is moderately well drained. Runoff is very slow, and there is no hazard of erosion where the soil is tilled and exposed. The depth to which roots can penetrate is limited to 40 to 50 inches by the water table. The available water capacity is 7 to 9 inches.

This soil is used for irrigated tomatoes, sugar beets, head lettuce, barley, and some alfalfa. Capability unit IIw–2(17).

Briones Series

The Briones series consists of well-drained and somewhat excessively drained soils underlain by soft, siliceous sandstone. These soils are on uplands. Slopes are 2 to 50 percent. Elevation ranges from 500 to 1,000 feet. The average annual temperature is 59° F., and the frost-free season is 250 to 300 days. The average annual rainfall is 14 to 20 inches. These soils are moist throughout from November to April and are dry from May to November in most years. Vegetation is forbs, annual grases, and scattered oaks. Some areas of brush are on severely eroded slopes.

In a representative profile the surface layer is grayish-brown, light brownish-gray, and brown, mainly strongly acid loamy sand about 23 inches thick. The substratum is faintly mottled, dark-brown and light-brown, slightly acid heavy loamy sand. It is underlain at a depth of 32 inches by yellowish-brown, soft sandstone.

The available water capacity is 1.0 to 5 inches. Roots can penetrate to a depth of 10 to 40 inches.

Briones soils are used for range, wildlife habitat, watershed, and homesites.

Representative profile of Briones loamy sand, 5 to 30 percent slopes, on a smooth, broad ridge that has a good cover of filaree and scattered oaks, near Dry Creek Dam in NE¼SW¼SE¼ sec. 22, T. 1 N., R. 2 E. (projected).

A11—0 to 2 inches, grayish-brown (10YR 5/2) loamy sand, dark brown (7.5YR 3/2) when moist; single grained; loose (dry and moist), nonsticky and nonplastic; many very fine roots; many, medium, interstitial pores and many, very fine, tubular pores; slightly acid; abrupt, smooth boundary.

A12—2 to 13 inches, light brownish-gray (10YR 6/2) loamy sand, dark brown (7.5YR 4/2) when moist; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; many, medium, interstitial pores and few, fine, tubular pores; strongly acid; clear, smooth boundary.

A13—13 to 23 inches, brown (10YR 5/3) loamy sand, dark brown (7.5YR 4/4) when moist; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; few, fine, tubular pores and many interstitial pores; strongly acid; abrupt, smooth boundary.

C1—23 to 32 inches, faintly mottled, dark-brown and light-brown (7.5YR 4/4 and 6/4) heavy loamy sand, dark brown (7.5YR 4/4) when moist; massive; slightly hard, friable, slightly sticky and nonplastic; few very fine roots; many, very fine, tubular pores and common, fine, interstitial pores; slightly acid; clear, smooth boundary.

C2r—32 to 50 inches, yellowish-brown (10YR 5/4), soft, coarse-grained sandstone.

The A11 horizon is grayish brown or brown. It is slightly acid or medium acid. The rest of the profile is light brownish gray, pale brown, brown, light brown, or dark brown. The C horizon above the sandstone is mottled in places. Depth to soft sandstone is generally 20 to 40 inches. In some eroded areas, the sandstone is at a depth of 10 inches.

BdE—Briones loamy sand, 5 to 30 percent slopes. This gently rolling to hilly soil is on uplands. It has the profile described as representative of the series.

Included with this soil in mapping are areas of Gaviota sandy loam near ridges that make up about 7 percent of the mapping unit. Also included are areas of San Ysidro loam in concave drainageways that make up 2 percent. Areas of a soil that has a surface layer of sandy loam and a subsoil of loam or light clay loam and that is underlain by soft interbedded sandstone or shale are also included. These areas make up 5 percent of the mapping unit.

This soil is well drained. Runoff is medium to rapid, and the hazard of erosion is moderate to high where the soil is tilled and exposed. Roots can penetrate to a depth of 20 to 40 inches. Permeability is rapid, and the available water capacity is 1.5 to 4 inches.

This soil is used mainly for range. A new areas are used for homesites. Capability unit VIe–1 (15) ; Sandy range site.

BdE2—Briones loamy sand, 15 to 30 percent slopes, eroded. This moderately steep soil is commonly on uplands, ridges, and south-facing slopes. About 25 to 75 percent of the surface layer has been removed by erosion, and shallow gullies are present in many places. The surface layer is about 6 to 17 inches thick. The depth to soft sandstone is 20 to 30 inches.

Included with this soil in mapping are areas of Gaviota sandy loam that make up about 10 percent of the mapping unit. Less than 1 percent of these areas have been altered by deep cuts and fills for homesites. Also included are large areas of soils that are 10 to 20 inches deep to sandstone.

This soil is somewhat excessively drained. Runoff is rapid, and the hazard of erosion is high where the soil is bare. Roots can penetrate to a depth of 20 to 30 inches. Permeability is rapid, and the available water capacity is 1.5 to 3 inches.

This soil is used for range, wildlife habitat, and watershed. Capability unit VIIe–1 (15) ; Sandy range site.

BdF—Briones loamy sand, 30 to 50 percent slopes. This steep soil is on uplands. It has a profile similar to the one described as representative of the series, but the surface layer is about 17 inches thick.

Included with this soil in mapping are areas of Gaviota sandy loam that make up about 12 percent of the mapping unit. Also included are areas of exposed sandstone that make up 2 percent.

This soil is somewhat excessively drained. Runoff is rapid, and the hazard of erosion is high where the soil is bare. Roots can penetrate to a depth of 20 to 30 inches. Permeability is rapid, and the available water capacity is 1.5 to 3 inches.

This soil is used for range, wildlife habitat, and watershed. Capability unit VIIe–1 (15) ; Sandy range site, steep.

BdF2—Briones loamy sand, 30 to 50 percent slopes, eroded. This steep soil is on uplands and in a few small, very steep areas. About 50 to 75 percent of the surface layer has been removed by erosion. The surface layer is about 10 to 12 inches thick.

Included with this soil in mapping are areas of Gaviota sandy loam that make up about 10 percent of the mapping unit. Erosion has removed all of the soil in some areas, exposing the soft bedrock. Hard rock outcrops make up 2 percent. Also included are large areas of soils that are 10 to 20 inches deep to bedrock.

This soil is somewhat excessively drained. Runoff is very rapid, and the hazard of erosion is very high where the soil is bare (fig. 3). Roots can penetrate to a depth of 10 to 30 inches. Permeability is rapid, and the available water capacity is 1.0 to 3 inches.

This soil is used for range, wildlife habitat, and watershed. Capability unit VIIe–1 (15); Sandy range site, steep.

BeB—Briones fine sandy loam, 2 to 5 percent slopes. This gently sloping soil is on fans. The surface layer is grayish-brown, strongly acid or medium acid fine sandy loam about 19 inches thick. Below that is mottled, brown and very pale brown, neutral to mod-

Figure 3.—**Erosion in this area of unprotected Briones soils during construction contributes to sedimentation of the streams and reservoir downslope.**

erately alkaline fine sandy loam and sandy loam. It is underlain at a depth of about 34 inches by weakly cemented, moderately alkaline heavy fine sandy loam. This soil has finer texture and poorer drainage than the other Briones soils in the county.

Included with this soil in mapping are areas that have sulfur springs that give off pungent odors, and the soils are extremely acid in some of these places. These areas make up less than 1 percent of the mapping unit.

This soil is moderately well drained. Permeability is moderately rapid in the upper part of the profile and moderately slow in the weakly cemented layer. Runoff is slow, and the hazard of erosion is slight where the soil is bare. Roots can penetrate to a depth of 30 to 40 inches. The available water capacity is 3.5 to 5 inches.

This soil is used for homesites and some dryland walnuts. The acid surface layer and the substratum that becomes hard after drying make landscaping of homesites difficult. Capability unit IIIs–4(17).

Capay Series

The Capay series consists of moderately well drained soils on lower edges of valley fill and on old benches that have been slowly dissected. These soils formed in alluvium from sedimentary rock. Slopes are 0 to 9 percent. Elevation ranges from 10 to 500 feet. The average annual temperature is 59° F., and the frost-free season is 250 to 300 days. The average annual rainfall is 14 to 16 inches. These soils are moist from late in December to early in May and are dry from June until October. Vegetation is annual grasses and a few scattered oaks.

In a representative profile the surface layer is dark grayish-brown and grayish-brown, slightly acid to moderately alkaline clay about 36 inches thick. The substratum is brown, calcareous clay and yellowish-brown, calcareous heavy silty clay loam that extends to a depth of 72 inches.

Permeability is slow, and the available water capacity is 6 to 10 inches. Roots can penetrate to a depth of 40 to more than 60 inches.

Capay soils are used for irrigated sugar beets, tomatoes, alfalfa, head lettuce, almonds, walnuts, apricots, and barley and for homesites.

Representative profile of Capay clay, 0 to 2 percent slopes, in a field used for row crops, 2 miles southwest of Oakley in NW¼NE¼NE¼ sec. 34, T. 2 N., R. 2 E.

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) when moist; moderate, coarse, angular blocky structure; extremely hard, very firm, sticky and very plastic; many very fine roots; very few, very fine, tubular pores; neutral; abrupt, smooth boundary.

A12—6 to 15 inches, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) when moist; moderate, very coarse, angular blocky structure; extremely hard, very firm, sticky and very plastic; many very fine roots; common, very fine, tubular pores; distinct slickensides; slightly acid; gradual, wavy boundary.

A13—15 to 27 inches, dark grayish-brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) when moist; moderate, coarse, angular blocky structure; extremely hard, very firm, sticky and very plastic; common very fine roots; common, very fine, tubular pores; prominent intersecting slickensides; neutral; gradual, wavy boundary.

A14—27 to 36 inches, grayish-brown (2.5Y 5/2) clay, very dark grayish brown (2.5Y 3/2) when moist; moderate, coarse, angular blocky structure; extremely hard, very firm, sticky and very plastic; few very fine roots; common, very fine, tubular pores; distinct slickensides; moderately alkaline; slightly effervescent; irregularly shaped concretions of lime; clear, wavy boundary.

C1ca—36 to 51 inches, brown (10YR 5/3) clay, dark brown (10YR 3/3) when moist; strong, very coarse, angular blocky structure; extremely hard, very firm, sticky and very plastic; very few very fine roots; few, very fine, tubular pores; moderately alkaline; slightly effervescent; disseminated lime and filaments and concretions of lime; clear, smooth boundary.

C2ca—51 to 72 inches, yellowish-brown (10YR 5/4) heavy silty clay loam, dark yellowish brown (10YR 4/4) when moist; weak, fine, subangular blocky structure; hard, friable, sticky and plastic; few, very fine, tubular pores; moderately alkaline; very slightly effervescent; irregular concretions of lime.

The A horizon is grayish brown, dark grayish brown, very dark grayish brown, or dark brown. It has moist chromas of 2 or more and a hue of 10YR or 2.5Y. Moist values are less than 3.5 in the upper 12 inches. The depth to free carbonates is 20 to 40 inches, and lime is in filaments, soft bodies, or concretions.

During the dry season cracks ½ inch to 2 inches wide extend from the surface into the upper part of the C horizon. The cracks form a very coarse and coarse prismatic structure.

The C horizon is brown, yellowish brown, pale brown, or olive brown and is heavy silt loam, silty clay loam, heavy silty clay loam, clay loam, or clay. It is very slightly effervescent to strongly effervescent. Lime is disseminated or in fine concretions.

CaA—Capay clay, 0 to 2 percent slopes. This nearly level soil is in basins or on low benches. It has the profile described as representative of the series.

Included with this soil in mapping are areas of Rincon clay loam on low terraces that make up about 7 percent of the mapping unit. Also included are areas of Brentwood clay loam in drainageways that make up 2 percent and areas of Marcuse clay that make up 1 percent.

Runoff is very slow, and there is no hazard of erosion where the soil is tilled and exposed. Roots can penetrate to a depth of more than 60 inches. The available water capacity is 8.5 to 10 inches.

This soil is used for irrigated sugar beets, tomatoes, head lettuce, almonds, walnuts, apricots, and barley. Capability unit IIs–5(17).

CaC—Capay clay, 2 to 9 percent slopes. About 70 percent of this soil is moderately sloping, and 30 percent is gently sloping and is on benches. Included with it in mapping are areas of Rincon clay loam that make up about 5 percent of the mapping unit. Also included are areas of Antioch loam that make up 5 percent and areas of Brentwood clay loam that make up 2 percent.

Runoff is slow, and the hazard of erosion is slight where the soil is tilled and exposed. Roots can penetrate to a depth of 60 inches. The available water capacity is 8.5 to 10 inches.

This soil is used mainly for dryland small grain, volunteer pasture, and range and for homesites. Capability unit IIe–5(17).

CbA—Capay clay, wet, 0 to 2 percent slopes. This nearly level soil formed in fine-textured alluvium on the lower edges of the flood plains of smaller creeks. It has a profile similar to the one described as representative of the series, but it has an intermittent water table between depths of 40 and 50 inches. This water table is caused by lateral movement of irrigation water from higher parts of the valley.

Included with this soil in mapping are areas of Rincon clay loam, wet, 0 to 2 percent slopes, that make up about 5 percent of the mapping unit. Also included are areas of Brentwood clay loam, wet, that make up 5 percent and areas of Marcuse clay that make up 5 percent.

Runoff is very slow, and there is no hazard of erosion where the soil is tilled and exposed. The depth to which roots can penetrate is limited to 40 to 50 inches by the water table. The available water capacity is 6 to 8 inches.

This soil is used for irrigated sugar beets, head lettuce, tomatoes, alfalfa, pasture, walnuts, and some almonds. Capability unit IIw–5(17).

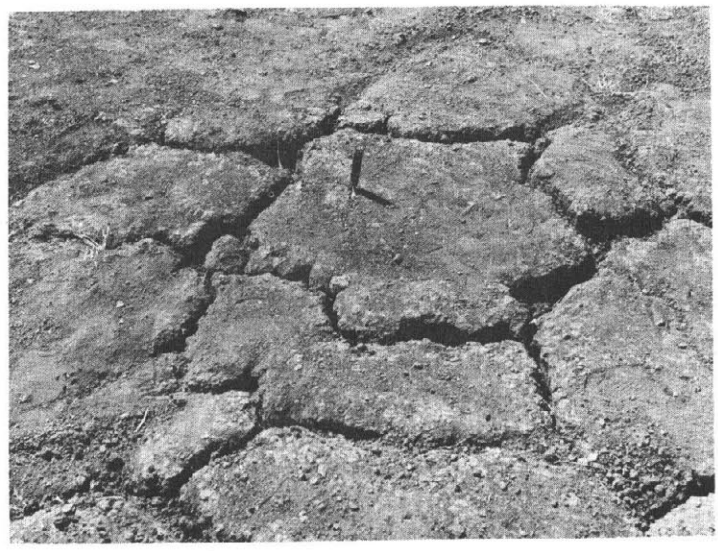

Figure 4.—**The high shrink-swell potential causes Clear Lake soils to crack.**

Clear Lake Series

The Clear Lake series consists of poorly drained soils in basins in the coastal valleys. These soils formed in fine-textured alluvium. Slopes are 0 to 2 percent. Elevation ranges from 100 to 1,000 feet. The average annual temperature is 59° F., and the frost-free season is 260 to 300 days. The average annual rainfall is 14 to 25 inches. These soils are dry from June to late in October and are moist from late in December to June in most years. Vegetation is annual grasses and forbs.

In a representative profile the surface layer is very dark gray, neutral and moderately alkaline clay about 46 inches thick. The substratum is mottled, very dark grayish-brown and grayish-brown, calcareous clay that extends to a depth of more than 60 inches.

Permeability is slow, and the available water capacity is 8 to 10 inches. Roots can penetrate to a depth of more than 60 inches. Clear Lake soils have a high shrink-swell potential that causes them to crack (fig. 4).

Clear Lake soils are used for dryland small grain and volunteer hay and as homesites.

Representative profile of Clear Lake clay, southeast of Danville in NE¼SW¼SW¼SE¼ sec. 12, T. 2 S., R. 1 E.

Ap—0 to 5 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) when moist; strong, coarse, prismatic structure parting to strong, medium, angular blocky; extremely hard, very firm, sticky and very plastic; common very fine and few fine roots; few, very fine, tubular pores; neutral; gradual, smooth boundary.

A12—5 to 20 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) when moist; strong, coarse, prismatic structure parting to strong, medium, angular blocky; extremely hard, very firm, sticky and very plastic; many very fine roots; few, very fine, tubular pores; many slickensides; neutral; gradual, wavy boundary.

A13—20 to 30 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) when moist; strong, coarse, prismatic structure parting to strong, medium, angular blocky; extremely hard, very firm, sticky and plastic; many very fine roots; few, very fine, tubular, inped pores; many interesecting slickensides; moderately alkaline; clear, wavy boundary.

ACca—30 to 46 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) when moist; common, medium, distinct, very dark grayish-brown (2.5Y 3/2) mottles, very dark grayish brown (10YR 3/2) when moist; strong, coarse, prismatic structure parting to strong, medium, angular blocky; extremely hard, very firm, sticky and very plastic; common very fine roots; few, very fine, tubular pores; many intersecting slickensides; moderately alkaline; slightly calcareous; disseminated lime and segregated lime in soft bodies; gradual, wavy boundary.

C—46 to 60 inches, mottled, very dark grayish-brown (2.5Y 3/2) and grayish-brown (2.5Y 5/2) light clay, very dark grayish brown (2.5Y 3/2) when moist; moderate, medium, subangular blocky structure; extremely hard, firm, sticky and plastic; few very fine roots; many, very fine, tubular pores; few slickensides; moderately alkaline; slightly calcareous; disseminated lime and lime in soft bodies.

The A horizon is dark gray, very dark gray, or black. It is slightly acid to moderately alkaline. In some places there are a few fine concretions of lime in the Ap horizon or A12 horizon. The ACca horizon is dark gray or very dark gray and has as much as 50 percent mottles of very dark grayish brown or dark brown in some places.

During the summer cracks from ½ inch to 2 inches wide extend from the surface into the C horizon. The cracks form very coarse and coarse prisms that part to strong and moderate, coarse and medium, angular and subangular blocky structure.

The C horizon is olive, light olive brown, grayish brown, dark grayish brown, or very dark grayish brown and is mottled in places. It is clay loam, silty clay loam, or light clay.

Cc—Clear Lake clay. This is the only Clear Lake soil mapped in the county. Its drainage has been improved by natural stream cutting, and the water table is below a depth of 60 inches in most places.

Included with this soil in mapping are areas of Cropley clay that make up about 7 percent of the mapping unit. Also included are areas of Pescadero clay loam that make up 3 percent and areas of Conejo clay loam

adjacent to small streams that make up 2 percent. Less than 1 percent of the areas mapped as this soil are slightly affected by accumulation of excess salts.

Runoff is very slow, and there is no hazard of erosion where the soil is tilled and exposed. The soil is subject to flooding once every 7 to 10 years unless surface drainage is provided.

This soil is used for dryland small grain and volunteer hay and for homesites. Capability unit IIs–5(17).

Conejo Series

The Conejo series consists of well drained and moderately well drained soils on valley fill. These soils formed in material from sedimentary rock. Slopes are 0 to 5 percent. Elevation ranges from 10 to 1,000 feet. The average annual air temperature is 59° F., and the frost-free season is 260 to 300 days. The average annual rainfall is 14 to 25 inches. These soils are moist from December to June and are dry from June to October in most years. Vegetation is annual grasses and forbs, scattered oaks, and a few sycamores along creeks.

In a representative profile the surface layer is dark-gray, neutral clay loam about 27 inches thick. The subsoil is grayish-brown, neutral clay loam about 14 inches thick. The substratum is mottled, grayish-brown and brown, neutral clay loam that extends to a depth of more than 60 inches.

Permeability is moderately slow, and the available water capacity is 7 to 12 inches. Roots can penetrate to a depth of 60 inches or more.

Conejo soils are used for dryland small grain and volunteer hay and for homesites.

Representative profile of Conejo clay loam, 0 to 2 percent slopes in a walnut orchard in SW¼SE¼SE¼ sec. 24, T. 1 S., R. 1 W.

Ap—0 to 6 inches, dark-gray (10YR 4/1) clay loam, very dark grayish brown (10YR 3/1) when moist; weak, fine, granular structure; hard, friable, sticky and plastic; many very fine roots; few, very fine and fine, interstitial pores; neutral; abrupt, wavy boundary.

A12—6 to 27 inches, dark-gray (10YR 4/1) clay loam, very dark gray (10YR 3/1) when moist; weak, fine, granular structure; hard, friable, sticky and plastic; few very fine and coarse roots and common medium roots;common, fine, tubular pores; neutral; diffuse, wavy boundary.

B2—27 to 41 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, subangular blocky structure; hard, friable, sticky and plastic; common fine roots; few, very fine, tubular pores; neutral; diffuse, wavy boundary.

C—41 to 60 inches, faintly mottled, grayish-brown and brown (10YR 5/2 and 5/3) clay loam, very dark grayish brown and dark brown (10YR 3/2 and 3/3) when moist; weak, fine, subangular blocky structure; hard, friable, sticky and plastic; few very fine and fine roots; common, very fine and fine, tubular pores; neutral.

The A horizon is gray, grayish-brown, or dark-gray clay loam or silty clay loam that is less than 35 percent clay. It has weak or moderate, fine or medium, granular or fine, subangular blocky structure. The A horizon is slightly acid to neutral.

The C horizon commonly has faint mottles, but in some places the mottles are distinct. It is massive or has weak or moderate, fine or very fine, subangular blocky structure. The C horizon is slightly calcareous in a few places.

CcA—Conejo clay loam, 0 to 2 percent slopes. This nearly level soil is in valleys. It has the profile described as representative of the series.

Included with this soil in mapping are areas of Botella clay loam on low terraces that make up about 10 percent of the mapping unit. Also included are concave areas of Clear Lake clay that make up 3 percent and areas of Garretson loam that make up 1 percent.

This soil is well drained. Runoff is slow, and there is no hazard of erosion where the soil is tilled and exposed. Roots can penetrate to a depth of 60 inches. The available water capacity is 10 to 12 inches.

This soil is used for dryland small grain and homesites. Capability unit I(17).

CeB—Conejo clay loam, 2 to 5 percent slopes. This gently sloping soil is on fans and in upland valleys. Included with it in mapping are areas of Botella clay loam that make up about 10 percent of the mapping unit and areas of Cropley clay that make up 5 percent.

This soil is well drained. Runoff is slow, and the hazard of erosion is slight where the soil is tilled and exposed. Roots can penetrate to a depth of more than 60 inches. The available water capacity is 10 to 12 inches.

This soil is used for dryland small grain and homesites. Capability unit IIe–1(17).

ChA—Conejo clay loam, clay substratum, 0 to 2 percent slopes. This nearly level soil is on flood plains. It has a profile similar to the one described as representative of the series, but it has a clay substratum at a depth of 40 to 50 inches.

Included with this soil in mapping are areas of Clear Lake clay that make up about 5 percent of the mapping unit. Also included are areas of a clay loam soil that is underlain by clay at a depth of 30 to 40 inches. These areas make up 10 percent.

Runoff is slow, and there is no hazard of erosion where the soil is tilled and exposed. Permeability is slow in the clay substratum. Roots can penetrate to a depth of 40 to 60 inches or more. The available water capacity is 7 to 12 inches.

This soil is used for homesites and for dryland small grain and volunteer hay. Capability unit IIs–3(17).

Cropley Series

The Cropley series consists of moderately well drained soils in small upland valleys. These soils formed in fine-textured alluvium from sedimentary rock. Slopes are 2 to 5 percent. Elevation ranges from 5 to 1,500 feet. The average annual air temperature is about 59° F., and the frost-free season is 260 to 300 days. The average annual precipitation is 14 to 20 inches. These soils are dry from late in May to late in October in most years. Vegetation is annual grasses, forbs, and scattered oaks.

In a representative profile the surface layer is dark-gray, slightly acid to moderately alkaline clay about 24 inches thick. Below that is dark-gray and dark-brown, calcareous clay about 10 inches thick. The

substratum is dark grayish-brown and dark-brown, strongly calcareous heavy clay loam to a depth of 44 inches. Below this it is yellowish-brown and very pale-brown, calcareous heavy clay loam that extends to a depth of more than 60 inches.

Permeability is slow, and the available water capacity is 8 to 10 inches. Roots can penetrate to a depth of 60 inches.

Cropley soils are used for dryland grain and range and for homesites.

Representative profile of Cropley clay, 2 to 5 percent slopes, on a low terrace north of the Mallard Reservoir in SW¼SW¼SW¼ sec. 12, T. 2 N., R. 2 W. (projected).

Ap—0 to 5 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) when moist; weak, fine, subangular blocky structure; very hard, firm, sticky and very plastic; many very fine roots; very few, fine, tubular pores; slightly acid; clear, smooth boundary.

A12—5 to 17 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) when moist; moderate, coarse, prismatic structure parting to moderate, medium, subangular blocky; very hard, very firm, sticky and plastic; common very fine roots; common, very fine, tubular pores; many intersecting slickensides; neutral; gradual, wavy boundary.

A13—17 to 24 inches, dark-gray (10YR 4/1) and very dark grayish brown (10YR 3/2) clay, very dark gray (10YR 3/1), very dark brown (10YR 3/2), and brown (10YR 4/3) when moist; moderate, coarse, prismatic structure parting to medium subangular blocky; very hard, firm, sticky and very plastic; few very fine roots; few, very fine, tubular pores; many intersecting slickensides; moderately alkaline; slightly effervescent; some segregated lime in seams; gradual, wavy boundary.

ACca—24 to 34 inches, dark-gray (10YR 4/1) and dark-brown (10YR 4/3) clay, very dark gray (10YR 3/1) and dark brown (10YR 3/3) when moist; moderate, coarse, prismatic structure parting to medium subangular blocky; very hard, firm, sticky and very plastic; very few fine roots; few, very fine, tubular pores; many intersecting slickensides; moderately alkaline; strongly effervescent; disseminated lime in seams and soft masses; gradual, wavy boundary.

C1ca—34 to 44 inches, dark grayish-brown (10YR 4/2) and dark-brown (10YR 3/3) heavy clay loam, dark yellowish brown (10YR 4/4) and light yellowish brown (10YR 6/4) when moist; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky; hard, firm, sticky and plastic; no roots; few, very fine, tubular pores; many intersecting slickensides; moderately alkaline; strongly effervescent; disseminated lime in seams and soft masses; gradual, wavy boundary.

C2—44 to 60 inches, yellowish-brown (10YR 5/4) and very pale brown (10YR 7/4) heavy clay loam, olive brown (2.5Y 4/4) and yellowish brown (10YR 5/4) when moist; moderate, medium, subangular blocky structure; firm, hard, sticky and plastic; few, very fine, tubular pores; some slickensides; moderately alkaline; very slightly effervescent; lime in seams.

The Ap and A12 horizons are dark gray, very dark gray, or black in a hue of 10YR. The Ap horizon has weak, granular structure in places. The A1 horizon is medium acid in some places. The A13 horizon is intermittently calcareous and has few, fine concretions of lime in places. Variegated colors in and below the A13 horizon are a result of mixing or churning from wetting and drying and of the segregation of lime. The ACca horizon is dark gray and dark brown or dark gray and yellowish brown in hues of 10YR and 2.5Y. It is silty clay or clay.

Cracks from ½ inch to 2 inches wide extend from the surface to a depth of 30 to 40 inches in dry periods. Intersecting slickensides are between the Ap horizon and the C2 horizon.

The C horizon is silty clay, heavy clay loam, or clay. The C1ca horizon is dark grayish brown and dark yellowish brown or grayish brown and yellowish brown in hues of 10YR and 2.5Y. The C2 horizon is yellowish brown, very pale brown, grayish brown, or olive brown in hues of 10YR or 2.5Y.

CkB—Cropley clay, 2 to 5 percent slopes. This gently sloping soil is commonly in small upland valleys. Included with it in mapping are a few areas where slopes are 5 to 9 percent. Also included are areas of Clear Lake clay along the lower toe slopes that make up about 5 percent of the mapping unit. Areas of Pescadero clay loam that make up 2 percent and areas of Conejo clay loam adjacent to small streams or drainageways that make up 5 percent are also included.

Runoff is slow, and the hazard of erosion is slight where the soil is tilled and exposed.

This soil is used for dryland grain and range and for homesites. Capability unit IIe-5(17).

Cut and Fill Land

Cut and fill land is the result of mechanical manipulation of upland areas for urban use. In this county, Cut and fill land is mapped in complexes with Diablo, Los Osos, and Millsholm soils.

CmE—Cut and fill land-Diablo complex, 9 to 30 percent slopes. This complex consists of 75 percent Cut and fill land, 15 percent Diablo clay, and 10 percent Altamont clay. Elevation ranges from 500 to 1,500 feet. The average annual air temperature is about 59° F., and the frost-free season is 260 to 300 days. The average annual rainfall is 15 to 20 inches.

Cut and fill land is the result of mechanical manipulation of strongly sloping to moderately steep soils on uplands for urban use. The building pads are nearly level. Exposed cuts have slopes of about 1.5:1 and are about 10 feet deep. Fill areas have slopes of about 2:1 and are about 8 feet thick.

The earthy material is heavy clay loam, silty clay, and clay. As much as 20 percent, by volume, is angular fragments of shale and sandstone. Colors are variable and have a hue of 10YR or 2.5Y. The material is mildly alkaline to moderately alkaline and is calcareous throughout. Exposed cuts consist of interbedded shale and fine-grained sandstone that contain varying amounts of lime. The bedrock dips 50 to 80 degrees.

This complex is well drained or somewhat excessively drained. Runoff is rapid, and the hazard of erosion is high. Permeability is slow to very slow depending upon compaction during construction.

This complex is used mainly for single-family dwellings at a density of two to four houses per acre. About 25 percent of the area is covered by streets, small shopping centers, and other urban structures.

All slopes in this complex should have a permanent cover of grass or close-spaced ornamental plants to minimize the hazard of erosion. An alternative to this is a gravel or cinder mulch that completely covers the soil surface. Nearly level areas are suited to a cover of

clean-tilled flowers or ornamental plants. Careful management of irrigation water is needed to maintain the soils, minimize erosion, and reduce the hazard of landslides. Surface and subsurface tile drains should be installed to remove excess water. The surface drains should be constructed at major slope changes. The outlets of all drains and downspouts should be protected to prevent gullying at outlets. Downspouts should empty into pipes that tie directly into storm drains.

Soil material used for subbase of patios and sidewalks should be compacted and should contain at least 4 inches of sand to reduce cracking.

Most plants on this complex respond to nitrogen and phosphorous fertilizers. The "acid loving" ornamental shrubs, such as azaleas, camellias, and rhododendrons, need sulfur and iron and aluminum chelates. Not assigned to a capability unit or range site.

CnE—Cut and fill land-Los Osos complex, 9 to 30 percent slopes. This complex consists of about 70 percent Cut and fill land, 15 percent Los Osos clay loam, 10 percent Alo clay, and 5 percent Sehorn clay. Also included in this mapping unit is a small area of very dark gray, calcareous clay that formed in ultrabasic rock. Elevation ranges from 500 to 1,500 feet. The average annual air temperature is about 59° F., and the frost-free season is 260 to 330 days. The average annual rainfall is 15 to 25 inches.

Cut and fill land is the result of mechanical manipulation of strongly sloping to moderately steep soils on uplands for urban use. The building pads are nearly level. Exposed cuts have slopes of about 1.5:1 and are 10 feet deep. Fill areas have slopes of about 2:1 and are about 8 feet thick.

The earthy material is heavy clay loam, silty clay, and clay. As much as 20 percent, by volume, is angular fragments of shale and sandstone. Colors are variable and have a hue of 10YR or 2.5Y. The material is slightly acid to mildly alkaline. A few areas are slightly calcareous. Exposed cuts consist of interbedded shale and fine-grained sandstone that dip about 50 to 80 degrees. Some of the shale slakes down when exposed to weathering and forms silty clay and clay soil material.

This complex is well drained or somewhat excessively drained. Runoff is rapid, and the hazard of erosion is high. Permeability is slow to very slow depending upon compaction during construction.

This complex is used mainly for single-family dwellings at a density of two to four houses per acre. About 25 percent of the area is covered by streets, small shopping centers, and other urban structures.

Careful management of water is needed to reduce the hazards of erosion and landslides. Slopes that consist of fill should have a permanent cover of vegetation that needs a minimum of irrigation water. Surface drains should be installed to remove excess water. The outlets of all drains and downspouts should be protected to prevent gullying.

Soil material used for subbase of patios and sidewalks should be compacted and should contain 4 inches of sand to reduce cracking.

Most plants on this complex respond to nitrogen fertilizer. For optimum growth of lawns, 2 pounds of nitrogen per 100 square feet should be applied about every 6 weeks from April through October. Not assigned to a capability unit or range site.

CoE—Cut and fill land-Millsholm complex, 9 to 30 percent slopes. This complex consists of about 75 percent Cut and fill land, 15 percent Millsholm loam, and 5 percent Lodo clay loam. The rest is Los Gatos loam and Gilroy clay loam. Elevation ranges from 500 to 1,500 feet. The average annual air temperature is about 59° F., and the frost-free season is 260 to 330 days. The average annual rainfall is 15 to 25 inches.

Cut and fill land is the result of mechanical manipulation of strongly sloping to moderately steep soils on uplands for urban use. Exposed cuts have slopes of about 1.5:1 and are 10 feet deep. Fill areas have slopes of about 2:1 and are about 8 feet thick.

The earthy material is loam, silt loam, clay loam, and light silty clay loam. As much as 25 percent, by volume, is angular fragments of shale and sandstone. Colors are variable and have a hue of 7.5YR or 10YR. The material is slightly acid to mildly alkaline. A few areas are slightly calcareous. Exposed cuts consist of interbedded shale, fine-grained sandstone, and some conglomerate. Exposed bedrock dips 30 to 80 degrees.

This complex is well drained or somewhat excessively drained. Runoff is rapid, and the hazard of erosion is high. Permeability is moderate to slow depending upon compaction during construction.

This complex is used mainly for single-family dwellings at a density of about two to four houses per acre. About 25 percent of the area is covered by roads, parking lots, and small shopping centers.

Careful management of water is needed to reduce the hazard of erosion and saturation of the filled areas. Slopes that consist of fill should have a permanent cover of vegetation that needs a minimum of irrigation water. Surface drains should be installed to remove excess water. The outlets of all drains and downspouts should be protected to prevent gullying.

Most plants on this complex respond to nitrogen fertilizer. For optimum growth of lawns, 2 pounds of nitrogen per 100 square feet should be applied about every 6 weeks from April through October. Not assigned to a capability unit or range site.

CoF—Cut and fill land-Millsholm complex, 30 to 50 percent slopes. This complex consists of about 60 percent Cut and fill land, 20 percent Millsholm loam, 10 percent Lodo clay loam, 5 percent Los Gatos loam, and 5 percent Los Osos clay loam. Elevation ranges from 500 to 1,500 feet. The average annual air temperature is about 59° F., and the frost-free season is 260 to 330 days. The average annual rainfall is 15 to 25 inches.

Cut and fill land is the result of mechanical manipulation of steep soils on uplands for urban use. The building pads are nearly level. Exposed cuts have slopes of about 1.5:1 and are about 15 feet deep. Fill areas have slopes of about 2:1 and are as much as 20 feet thick.

The earthy material is loam, silt loam, and light silty clay loam. It contains 35 to 50 percent, by volume, angular fragments of shale and sandstone below a depth of 12 inches. Colors are variable and have a hue of 7.5YR or 10YR. The material is slightly

acid to mildly alkaline. A few areas are slightly calcareous. Exposed cuts consist of interbedded shale, fine-grained sandstone, and some conglomerate. Exposed bedrock dips 30 to 80 degrees.

This complex is well drained or somewhat excessively drained. Runoff is rapid to very rapid, and the hazard of erosion is high to very high. Permeability is moderate to slow depending upon compaction during construction.

This complex is used mainly for single-family dwellings at a density of less than one house per acre. About 15 percent of the area is covered by roads and other urban structures.

Plants selected for landscaping and stabilizing banks should be drought resistant. Use of irrigation water should be kept to a minimum. Terraces should be used on long slopes to reduce erosion. Surface drains should be installed to remove excess water. The outlets of all drains and downspouts should be protected to prevent gullying. Mechanical structures are needed in places to control shallow mud flows.

Most plants on the complex respond to nitrogen fertilizer. For optimum growth of lawns, 2 pounds of nitrogen per 100 square feet should be applied about every 6 weeks from April through October. Vegetative cover other than lawns helps to reduce the hazard of soil saturation by over-irrigation. Sloping soils that are not landscaped should be mulched, fertilized, and seeded to annual grasses and legumes. Not assigned to a capability unit or range site.

Delhi Series

The Delhi series consists of somewhat excessively drained soils. These soils formed in wind-modified stream deposits of mixed origin. Slopes are 2 to 9 percent. Elevation ranges from 10 to 150 feet. The average annual air temperature is 59° F., and the frost-free season is 260 to 300 days. The average annual rainfall is 12 to 14 inches. These soils are generally moist to a depth of 60 inches from December through February and are dry from May through October in most years. Vegetation is annual grasses, forbs, and scattered California live oaks.

In a representative profile the surface layer is slightly acid, brown sand about 5 inches thick. The substratum is yellowish-brown, slightly acid to mildly alkaline sand that extends to a depth of 60 inches or more.

Permeability is rapid, and the available water capacity is about 3.75 inches. Roots can penetrate to a depth of more than 60 inches.

Delhi soils are used for irrigated almonds, vineyards, and some walnuts.

Representative profile of Delhi sand, 2 to 9 percent slopes, 1 mile southeast of Oakley near the intersection of Laurel Road and Rose Avenue in SE¼SE¼ SW¼ sec. 25, T. 2 N., R. 2 E.

Ap—0 to 5 inches, brown (10YR 5/3) sand, dark yellowish brown (10YR 3/4) when moist; single grained; loose when dry and moist, nonsticky and nonplastic; many, fine and very fine roots; many, very fine, interstitial pores; slightly acid; clear, smooth boundary.

C1—5 to 21 inches, yellowish-brown (10YR 5/4) sand, dark yellowish brown (10YR 3/4) when moist; single grained; loose when dry and moist, nonsticky and nonplastic; very few fine, very fine, and medium roots; many, fine, interstitial pores; slightly acid; diffuse, wavy boundary.

C2—21 to 34 inches, yellowish-brown (10YR 5/4) sand, dark yellowish brown (10YR 4/4) when moist; single grained; loose when dry and moist, nonsticky and nonplastic; very few fine, very fine, and medium roots; many, fine, interstitial pores; mildly alkaline.

C3—34 to 60 inches, yellowish-brown (10YR 5/4) sand, yellowish brown (10YR 5/4) when moist; single grained; loose when dry and moist, nonsticky and nonplastic; no roots; many very fine pores; mildly alkaline.

The A horizon is brown or light brownish gray in a hue of 10YR. It is typically sand but is loamy sand in places. It is slightly acid to neutral.

The C horizon is brown or yellowish brown in a hue of 10YR. It is typically sand but is loamy sand in places. It is neutral to mildly alkaline.

DaC—Dehli sand, 2 to 9 percent slopes. This is the only Delhi soil mapped in the county. Included with it in mapping are areas of Laugenour loam in places near the delta. These areas make up about 3 percent of the mapping unit. Also included are an area of sandy loam soils that have a faint subsoil consisting of lamellae and about 80 acres of soils that are similar to Delhi sand but that have a fluctuating water table between depths of 4 and 5 feet. Areas of Delhi sand that have slopes of 0 to 2 percent are also included.

Runoff is slow or very slow, and the hazards of soil blowing and water erosion are slight where the soil is tilled and exposed.

This soil is used for irrigated almonds, vineyards, and some walnuts. Capability unit IIIs–4(17).

Diablo Series

The Diablo series consists of well-drained soils underlain by calcareous, soft, fine-grained sandstone and shale. These soils are on uplands. Slopes are 9 to 50 percent. Elevation ranges from 400 to 1,200 feet. The average annual air temperature is 59° F., and the frost-free season is 260 to 300 days. The average annual rainfall is 14 to 20 inches. These soils are generally moist to a depth of 30 inches from November to May and are dry from June to mid-October in most years. Vegetation is annual grasses, forbs, and a few scattered oaks.

In a representative profile the surface layer is about 29 inches thick. It is dark-gray, moderately alkaline clay in the upper 18 inches and mixed dark-gray and light-gray, calcareous clay in the lower 11 inches. Below that is mixed dark-gray, olive-gray, and light-gray, calcareous clay about 9 inches thick. The substratum is mixed light-gray and olive-gray, strongly calcareous silty clay that is underlain at a depth of about 42 inches by calcareous, soft shale.

Permeability is slow, and the available water capacity is 6 to 9 inches. Roots can penetrate to a depth of 40 to 60 inches.

Diablo soils are used for range, dryland small grain, and volunteer hay and for some homesites.

Representative profile of Diablo clay, 9 to 15 per-

cent slopes, on a southeast-facing slope east of Dougherty Road in NE¼SW¼SE¼ sec. 1, T. 2 S., R. 1 W.

Ap—0 to 5 inches, dark-gray (N 4/0) clay, dark gray (N 4/0) when moist; moderate, coarse, prismatic structure parting to moderate, medium, angular blocky; extremely hard, very firm, sticky and very plastic; many very fine and fine roots; few, very fine tubular pores; moderately alkaline; clear, wavy boundary.

A12—5 to 18 inches, dark-gray (N 4/0) clay, dark gray (N 4/0) when moist; moderate, coarse, prismatic structure parting to moderate, medium, angular blocky; extremely hard, very firm, sticky and very plastic; many very fine roots; few, very fine tubular pores; few slickensides; moderately alkaline; slightly calcareous; disseminated lime and lime in soft masses; gradual, wavy boundary.

A13—18 to 29 inches, mixed dark-gray (N 4/0) and light-gray (2.5Y 7/2) clay, dark gray (N 4/0) and light grayish brown (2.5Y 6/2) when moist; strong, coarse, prismatic structure parting to medium, angular blocky; extremely hard, very firm, sticky and very plastic; many very fine roots; few, very fine tubular pores; numerous slickensides; moderately alkaline; slightly calcareous; disseminated lime and lime in soft masses; gradual, wavy boundary.

ACca—29 to 38 inches, mixed dark-gray, olive-gray, and light-gray (N 4/0 and 5Y 5/1, 5/2, and 7/2) clay, dark gray, olive gray, and light gray (N 4/0 and 5Y 4/2, 5/2, and 7/2) when moist; moderate, very coarse, prismatic and medium, blocky structure; extremely hard, very firm, sticky and plastic; few very fine roots; common very fine pores; few slickensides; moderately alkaline; slightly calcareous; disseminated lime and lime in soft masses; gradual, wavy boundary.

C1ca—38 to 42 inches, mixed light-gray (5Y 7/2) and olive-gray (5Y 5/2) silty clay, light gray (5Y 7/2) and olive gray (5Y 4/2) when moist; moderate, coarse, angular blocky structure; very hard, friable, sticky and plastic; few very fine roots; few, very fine, discontinuous, tubular pores; moderately alkaline; strongly effervescent; disseminated lime and lime in soft masses and concretions; clear, wavy boundary.

Cr2ca—42 to 60 inches, gray (5Y 5/1), slightly calcareous, shattered shale; white films on fracture faces.

The A horizon ranges from very dark gray to gray in hues of N, 10YR, 2.5Y and 5Y. The lower part of the A horizon has faint mottles that are a result of mixing. The A horizon is commonly clay but is silty clay in places. It is neutral to moderately alkaline in the upper part and is generally moderately alkaline in the lower part. The Ap horizon or A11 horizon is rarely calcareous. The amount of lime tends to increase with depth.

A strong granular or strong, fine, blocky structure generally develops in the top few inches at the surface upon drying. Cracks as wide as 4 inches at the surface extend from the A horizon into the upper part of the parent rock after long dry periods. The cracks are generally open from July through September. They form a coarse prismatic structure. Slickensides intersect.

The ACca horizon is dark gray, olive gray, or light gray in hues of N, 10YR, 2.5Y, and 5Y. Values are as high as 7. The ACca horizon is clay or silty clay. It has large, blotchy, faint mottles in hues of 2.5Y and 5Y that are a result of the mixing of horizons. Lime is disseminated and is segregated in places.

The C horizon is grayish brown, light gray, or olive gray in hues of 2.5Y and 5Y. The C1ca horizon is clay or silty clay, and the Cr2ca horizon is fractured shale. The C horizon is moderately alkaline. Lime is generally soft masses and films.

Depth to shale and sandstone ranges from 40 to 60 inches.

DdD—Diablo clay, 9 to 15 percent slopes. This rolling soil is commonly on smooth uplands. It has the profile described as representative of the series.

Included with this soil in mapping are areas of Cropley clay along small drainageways or concave areas that make up about 8 percent of the mapping unit. Also included are areas of Altamont clay that make up 7 percent.

Runoff is slow to medium, and the hazard of erosion is slight to moderate where the soil is tilled and exposed.

This soil is used mainly for dryland small grain, range, and volunteer hay. A few areas are used for homesites. Capability until IIIe–5(15); Clayey range site.

DdE—Diablo clay, 15 to 30 percent slopes. This hilly soil is on smooth uplands. Included with it in mapping are areas of Sehorn clay that make up about 5 percent of the mapping unit, areas of Alo clay that make up 4 percent, areas of Altamont clay that make up 4 percent, and areas of Cropley clay that make up 2 percent.

Runoff is medium, and the hazard of erosion is moderate where the soil is tilled and exposed.

This soil is used for range, dryland small grain, and some volunteer hay. Capability unit IVe–5(15); Clayey range site.

DdF—Diablo clay, 30 to 50 percent slopes. This steep soil is on uplands. Included with it in mapping are areas of Alo clay that make up about 8 percent of the mapping unit, areas of Sehorn clay that make up 5 percent, and areas of Lodo clay loam that make up 2 percent.

Runoff is medium to rapid, and the hazard of erosion is moderate to high where the soil is bare.

This soil is used for range, watershed, and wildlife habitat. Capability until VIe–1(15); Clayey range site, steep.

Dibble Series

The Dibble series consists of well-drained soils underlain by soft, interbedded shale and sandstone. Slopes are 15 to 50 percent. Elevation ranges from 500 to 7,500 feet. The average annual air temperature is 58° F., and the frost-free season is 250 to 280 days. The average annual rainfall is 5 to 25 inches. These soils are moist from November to June and are dry from June to mid-October in most years. Vegetation is annual grasses, forbs, and oak. On north-facing slopes, coyote bush, poison-oak, bay leaf, and oak make up a large part of the vegetation.

In a representative profile the surface layer is pale-brown, medium acid silty clay loam about 10 inches thick. The subsoil is about 20 inches thick. It is pale-brown, slightly acid light silty clay in the upper 7 inches, light brownish-gray and light yellowish-brown, slightly acid silty clay in the next 8 inches, and yellowish-brown and light olive-brown, neutral silty clay loam in the lower 5 inches. It is underlain at a depth of about 30 inches by pale-olive, soft shale or siltstone.

Permeability is slow in the subsoil, and the available

water capacity is 4 to 7 inches. Roots can penetrate to a depth of 20 to 36 inches.

Dibble soils are used for range and wildife habitat. A few areas are used for homesites.

Representative profile of Dibble silty clay loam, 15 to 30 percent slopes, on a convex, southwest-facing slope in NW¼NE¼NW¼ sec. 13, T. 1 S., R. 1 W.

A11—0 to 6 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 4/3) when moist; weak, fine, granular structure; hard, friable, slightly sticky and slightly plastic; common very fine roots; common, fine, tubular pores and many, very fine tubular and interstitial pores; medium acid; clear, wavy boundary.

A12—6 to 10 inches, pale-brown (10YR 6/3) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; weak, fine, granular structure; hard, friable, sticky and plastic; few very fine roots; common, fine and very fine and few, medium, tubular pores; medium acid; gradual, irregular boundary.

B21t—10 to 17 inches, pale-brown (10YR 6/3) light silty clay, olive brown (2.5Y 4/4) when moist; few, fine, brown mottles; weak, coarse, subangular blocky structure; hard, firm, sticky and plastic; very few very fine roots; few, very fine and fine, tubular pores and very few, medium tubular pores; common thin clay films on ped faces, as bridges, and in pores; slightly acid; gradual, irregular boundary.

B22t—17 to 25 inches, light brownish-gray (2.5Y 6/2) and light yellowish-brown (2.5Y 6/4) silty clay that has olive-yellow (2.5Y 6/6) mottles, olive brown (2.5Y 4/4) with light olive-brown (2.5Y 5/6) mottles when moist; weak, coarse, subangular blocky structure; hard, firm, sticky and plastic; very few very fine roots; few, very fine tubular pores; few thin clay films lining pores; slightly acid; gradual, irregular boundary.

B3—25 to 30 inches, light yellowish-brown (2.5Y 6/4) and light olive-brown (2.5Y 5/4 and 5/6) silty clay loam, olive brown (2.5Y 4/4) and light olive brown (2.5Y 5/6) when moist; weak, medium subangular blocky structure; hard, firm, sticky and plastic; very few very fine roots; few, very fine tubular pores; few thin clay films lining pores; neutral; abrupt boundary.

Cr—30 to 40 inches, pale-olive (5Y 6/3) soft shale or siltstone, olive (5Y 5/3) when moist.

The A horizon is 7 to 14 inches thick. It is light brownish gray, pale brown, or light yellowish brown in hues of 10YR and 2.5Y. Moist values are 4 or more. The A horizon is loam, silt loam, or silty clay loam. It is medium acid or slightly acid.

The B2t horizon is 10 to 18 inches thick. It is brown, yellowish brown, light brownish gray, pale brown, light yellowish brown, or pale olive brown. Mottles are faint or nonexistent. The B2t horizon is silty clay, light clay, or heavy clay loam. It is slightly acid or neutral. The B3 horizon is 3 to 6 inches thick and contains as much as 25 percent, by volume, angular fragments of parent rock less than 3 inches in diameter.

The Cr horizon is calcareous in places.

DeE—Dibble silty clay loam, 15 to 30 percent slopes. This hilly soil is on uplands. It has the profile described as representative of the series.

Included with this soil in mapping are areas of Los Gatos loam over slightly harder sandstone that make up about 5 percent of the mapping unit. Areas of Los Osos clay loam on north-facing slopes that make up 4 percent, areas of Millsholm loam along the crest of hills that make up 3 percent, and areas of Gaviota sandy loam that make up 2 percent are also incuded. Areas of deep, loamy soil in small concave drainageways that are commonly gullied by water erosion make up 1 percent. Also included are a few small areas of Dibble silty clay loam that has slopes of 9 to 15 percent.

Runoff is medium, and the hazard of erosion is moderate where the soil is bare.

This soil is used for range and a few homesites. Capability unit IVe–3(15); Loamy range site.

DeF—Dibble silty clay loam, 30 to 50 percent slopes. This steep soil is on uplands. Included with it in mapping are areas of Los Gatos loam over hard sandstone that make up about 6 percent of the mapping unit and areas of Los Osos clay loam that make up 5 percent. Also included are areas of Millsholm loam, commonly along ridgetops, that make up 2 percent and areas of Gaviota sandy loam over coarse-grained sandstone that make up as much as 2 percent.

Runoff is medium to rapid, and the hazard of erosion is moderate to high where the soil is bare.

This soil is used for range, wildlife habitat, and watershed. Capability unit VIe–1(15); Loamy range site, steep.

Egbert Series

The Egbert series consists of very poorly drained soils on level tracts of the San Joaquin River delta. Drainage has been altered by the use of reclamation structures. These soils formed in alluvium in old stream channels and other areas. Slopes are 0 to 2 percent. Elevation ranges from 5 to 15 feet below sea level. The average annual air temperature is 60° F., and the frost-free season is 250 to 300 days. The average annual rainfall is 12 to 14 inches. Vegetation is annual grasses, forbs, rushes, and sedges.

In a representative profile the surface layer is very dark gray, medium acid mucky clay loam about 16 inches thick. The subsoil is mottled, grayish-brown, strongly acid silty clay about 12 inches thick. The upper part of the substratum, to a depth of 46 inches, is mottled, olive-gray silty clay. The lower part is greenish-gray clay that extends to a depth of 72 inches or more. The substratum is medium acid in the upper part and moderately alkaline in the lower part. Small gypsum crystals are in the upper part of the substratum.

Permeability is slow, and the available water capacity is 6 to 8 inches. Roots can penetrate to a depth of 40 to 50 inches. The seasonal high water table is within a depth of 20 inches, but during the growing season it is kept at a depth of 40 to 50 inches by draining and pumping.

Egbert soils are used for irrigated asparagus, field corn, milo, and barley and for wildlife habitat and recreation areas.

Representative profile of Egbert mucky clay loam on Byron Tract in SE¼NW¼NE¼ sec. 1, T. 1 S., R. 3 E. (projected).

Ap—0 to 8 inches, very dark gray (10YR 3/1) mucky clay loam, black (N 2/0) when moist; weak, coarse, prismatic structure parting to weak, fine, subangular blocky; slightly hard, very friable, slightly

sticky and slightly plastic; very few very fine roots; very few, fine, tubular pores; medium acid; approximately 10 percent organic matter; diffuse, smooth boundary.

A12—8 to 16 inches, similar to Ap horizon, but structure is moderate; small pockets of pale-brown ashy material throughout; a 1-inch layer at a depth of 15 inches is dark reddish-brown (5YR 3/2 and 2/2), has weak, medium, platy structure, and is approximately 20 percent organic matter; abrupt, smooth boundary.

B21g—16 to 21 inches, grayish-brown (10YR 5/2) light silty clay, very dark grayish brown (10YR 3/2) and very dark brown (10YR 2/2) when moist; common, fine, prominent, strong-brown (7.5YR 5/6) mottles; moderate, very coarse, prismatic structure; prisms are 5 to 10 inches in width; very hard, firm, sticky and very plastic; common very fine roots; common, very fine, tubular pores; strongly acid; gradual, smooth boundary.

B22g—21 to 28 inches, grayish-brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) and very dark brown (10YR 2/2) when moist; common, fine, prominent, strong-brown (7.5YR 5/6) mottles; moderate, very coarse, prismatic structure; very hard, firm, sticky and very plastic; few very fine roots; common, very fine, tubular pores; strongly acid; clear, smooth boundary.

IIClg—28 to 46 inches, olive-gray (5Y 5/2) silty clay, dark gray (5Y 4/1) when moist; many, fine, prominent, reddish-brown mottles; massive; very hard, friable, sticky and plastic; very few very fine roots; many, very fine, tubular pores; medium acid; small pockets of fine gypsum crystals; diffuse, smooth boundary.

IIC2g—46 to 72 inches, greenish-gray (5GY 6/1) clay, greenish gray (5GY 5/1) when moist; many, large, prominent, yellowish-brown (10YR 5/6) mottles; massive; very hard, friable, sticky and plastic; moderately alkaline; slightly calcareous; lime is disseminated and in seams.

The A horizon is 12 to 17 inches thick. It ranges in moist color from black (10YR 2/1, N 2/0) to dark brown (10YR 3/3), and intermediate colors are 10YR 2/2, 3/1, and 3/2, N 3/0, and 2.5Y 3/2. It is clay loam, silty clay loam, light clay, or light silty clay that is 2 to 10 percent organic matter. The A horizon has weak, coarse, prismatic or subangular blocky structure parting to weak, fine, subangular blocky or coarse, granular structure. It is medium acid to neutral.

The B horizon ranges from very dark gray to very dark brown or grayish brown in hues of 10YR, N, and 2.5Y. Mottles are prominent or distinct. The B horizon is heavy clay loam, heavy silty clay loam, clay, or silty clay. It is strongly acid or medium acid. The upper part of the B horizon has weak or medium, coarse or very coarse, prismatic, subangular blocky, or angular blocky structure.

The IIC horizon is olive or gleyed and has moist values of 4 or 5. It contains as much as 5 percent more clay than the B horizon.

Very fine mica flakes are throughout the profile in places. Thin organic strata can occur anywhere in the upper 40 inches of the profile. In places, buried organic soils are at depths of more than 40 inches.

Ea—Egbert mucky clay loam. Small areas of this soil are on the San Joaquin River delta in old natural channels. Larger areas are between organic and mineral soils. This is the only Egbert soil mapped in the county.

Included with this soil in mapping are areas of Kingile muck that make up about 6 percent of the mapping unit, areas of Ryde silt that make up 3 percent, and areas of Merritt loam that make up 2 percent. Also included are areas of soils that are similar to Egbert soils but that have an organic soil at least 16 inches thick buried at a depth of 20 to 40 inches. This is caused by leveling for irrigation.

Runoff is very slow, and there is no hazard of erosion where the soil is tilled and exposed.

This soil is used for irrigated asparagus, field corn, milo, and barley and wildlife habitat and recreation areas. Capability unit IIIw–2(16).

Felton Series

The Felton series consists of well-drained soils underlain by sandstone. These soils are on north-facing slopes on uplands. Slopes are 50 to 75 percent. Elevation ranges from 500 to 1,500 feet. The average annual air temperature is 56° F., and the frost-free season is 260 to 300 days. The average annual rainfall is 25 to 30 inches. These soils are moist from October to July and are dry from July to October in most years. Vegetation is coastal redwood, some madrone, and an understory of ferns.

In a representative profile the surface layer is dark reddish-gray, slightly acid loam about 19 inches thick. The subsoil is brown, slightly acid gravelly clay loam and is underlain at a depth of 42 inches by sandstone.

Permeability is moderately slow, and the available water capacity is 5 to 7 inches. Roots can penetrate to a depth of 40 to 50 inches.

Felton soils are used for recreation areas and watershed.

Representative profile of Felton loam, 50 to 75 percent slopes, on a north-facing slope that has a dense stand of coastal redwood, in SE¼SW¼ sec. 22, T. 1 S., R. 3 W.

A11—0 to 10 inches, dark reddish-gray (5YR 4/2) loam, dark reddish brown (5YR 2/2) when moist; strong, medium, granular structure; soft, friable, slightly sticky and slightly plastic; many fine and medium and few very fine roots; few very fine and common fine pores; slightly acid; diffuse, smooth boundary.

A12—10 to 19 inches, dark reddish-gray (5YR 4/2) heavy loam, dark reddish brown (5YR 2/2) when moist; strong, medium, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and medium and few very fine and coarse roots; few very fine and common fine pores; slightly acid; clear, smooth boundary.

B2t—19 to 33 inches, brown (7.5YR 5/4) gravelly clay loam, yellowish brown (10YR 5/4) when moist; moderate, fine, subangular blocky structure; slightly hard, friable, sticky and plastic; few very fine, many fine and medium, and common coarse roots; few very fine pores; common thin clay films on ped faces and in pores; 15 to 25 percent gravel fragments of parent rock; slightly acid; clear, wavy boundary.

B3t—33 to 42 inches, brown (7.5YR 4/4) gravelly clay loam, brown (7.5YR 4/4) when moist; moderate, fine, subangular blocky structure; slightly hard, friable, sticky and plastic; few very fine, medium, and coarse, and common fine roots; few very fine pores; common thin clay films on ped faces and in pores; 25 to 35 percent gravel fragments of parent rock; slightly acid; diffuse, irregular boundary.

Cr—42 to 50 inches, light yellowish-brown and reddish-brown, soft, interbedded sandstone and shale; slightly acid; cracks filled with material from B3t horizon.

The A horizon is 15 to 23 inches thick. It is reddish gray, dark reddish brown, dark reddish gray, or brown in hues of 5YR and 7.5YR and is loam or silt loam. Its structure ranges from strong or moderate, fine to coarse, granular to moderate, fine or medium, subangular blocky. The A horizon is medium acid or slightly acid.

The B2t horizon is 12 to 16 inches thick. It has values of 5 or 6, chromas of 3 or 4, and hues of 7.5YR and 10YR, and moist values are 4 or more. It is mottled in places. If it is mottled, the matrix commonly has a hue of 10YR, and the mottles have a hue of 7.5YR. The B2t horizon is gravelly heavy loam to gravelly clay loam. It has moderate, fine or medium, subangular blocky to coarse, granular structure. It is medium acid or slightly acid.

The B3t horizon is 8 to 11 inches thick. It has values of 4, 5, or 6 in places, but otherwise the color range is the same as for the B2t horizon. It contains 10 to 20 percent more gravel by volume than the B2t horizon. It is medium acid or slightly acid.

The Cr horizon consists of interbedded sandstone and shale. It has reddish-brown coatings on the faces of fragments in places.

Depth to interbedded sandstone and shale is 40 to 50 inches.

FaG—Felton loam, 50 to 75 percent slopes. This is the only Felton soil mapped in the county. Outcropping bedrock covers 5 to 10 percent of the surface in places.

Included with this soil in mapping are areas of Gilroy clay loam that make up about 10 percent of the mapping unit and areas of Los Gatos loam that make up 2 percent.

Runoff is rapid, and the hazard of erosion is high where the soil is bare.

This soil is used for recreation areas and watershed. Capability unit VIIe–1 (15).

Fluvaquents

Fc—Fluvaquents are very poorly drained, loamy, mineral soils in sloughs and river channels. They are stratified fine sandy loam, loam, silt loam, and silty clay loam and have lenses of organic material as much as 4 inches thick. The surface layer is about 4 inches thick. It generally contains many fibrous roots.

Included in this mapping unit are some levee remnants from the flooding of Franks Tract and Big Break.

Fluvaquents are subject to frequent flooding or inundation by high tides, runoff water, or both during the rainy season.

The vegetation is tules, reeds, some willows, and other hydrophytic plants. Use of this mapping unit is limited to wildlife habitat. Capability unit VIIIw–1 (16).

Fontana Series

The Fontana series consists of well-drained soils underlain by calcareous, fine-grained sandstone. These soils are on uplands. They are mapped in complexes with Altamont soils. Slopes range from 9 to 75 percent but are mainly 30 to 75 percent. Elevation ranges from 500 to 1,500 feet. The average annual air temperature is 60° F., and the frost-free season is 260 to 300 days. The average annual rainfall is 12 to 16 inches. These soils are generally moist from December to May and are dry from May to November in most years. Vegetation is annual grasses, forbs, and scattered oaks.

In a representative profile the surface layer is dark grayish-brown, moderately alkaline silty clay loam about 16 inches thick. The substratum is yellowish-brown, highly calcareous silty clay loam. It is underlain by fine-grained sandstone and shale at a depth of 22 inches.

Permeability is moderately slow, and the available water capacity is 3.5 to 6.5 inches. Roots can penetrate to a depth of 20 to 36 inches.

Fontana soils are used for range.

Representative profile of Fontana silty clay loam, in an area of Fontana-Altamont complex, on a smooth, south-facing slope in NE¼NE¼SW¼ T. 1 S., R. 3 E.

A11—0 to 10 inches, dark grayish-brown (10YR 4/2) silty clay loam, dark brown (10YR 3/3) when moist; moderate, medium, angular blocky structure parting to moderate, fine, granular; hard, sticky and plastic; friable; few fine and common very fine pores; moderately alkaline; few lime concretions; gradual, wavy boundary.

A12ca—10 to 16 inches, dark grayish-brown (10YR 4/2) silty clay loam, dark brown (10YR 3/3) when moist; moderate, medium, angular blocky structure parting to moderate, fine, granular; hard, friable, very sticky and plastic; few fine and many very fine roots; few fine and common very fine pores; moderately alkaline; moderately calcareous; lime concretions; clear, broken boundary.

C1ca—16 to 22 inches, yellowish-brown (10YR 5/6) silty clay loam, dark yellowish brown (10YR 4/4) when moist; moderate, medium, angular blocky structure; hard, friable, very sticky and plastic; few fine and common very fine roots; few fine and many very fine pores; moderately alkaline; highly calcareous; matrix has disseminated lime and lime in concretions and filaments; abrupt, wavy boundary.

C2—22 to 36 inches, pale-yellow (2.5Y 7/4) and light olive-brown (2.5Y 5/4) fine-grained sandstone and shale; lime along cleavages.

The A horizon is dark grayish brown, grayish brown, or brown in hues of 10YR and 2.5Y. It ranges from clay loam to silty clay loam. It has moderate to strong, fine and medium, subangular and angular blocky or coarse, granular structure. The A11 horizon is 8 to 14 inches thick. It is slightly acid to moderately alkaline and is calcareous in places because of mixing by tilling or rodents. The A12ca horizon is 6 to 10 inches thick.

The C1ca horizon is 6 to 12 inches thick. It is yellowish brown or olive brown.

Depth to interbedded fine-grained sandstone and shale is 20 to 36 inches.

Fd—Fontana-Altamont complex. This complex is on foothills in the eastern uplands of the county. It consists of about 55 percent Fontana silty clay loam and 30 percent Altamont clay. About 10 percent is Millsholm loam, and as much as 5 percent is rock outcrop. Slopes are generally 15 to 30 percent, but they are 9 to 15 percent in some areas. Both soils have the profile described as representative of their series. Fontana soils are on south-facing slopes and knolls or crests. Altamont soils are on north-facing or lower foot slopes.

Where the soils are tilled and exposed, runoff is slow to medium and the hazard of erosion is slight to moderate. The rock outcrops make tillage difficult.

The soils in this complex are used for range. Capability unit IVe–5 (15) ; Clayey range site.

Garretson Series

The Garretson series consists of well-drained soils on alluvial fans and flood plains of small creeks. These soils formed in alluvium from sedimentary rock. Slopes are 0 to 5 percent. Elevation ranges from 100 to 500 feet. The average annual air temperature is 59° F., and the frost-free season is 250 to 300 days. The average annual rainfall is 14 to 20 inches. These soils are moist to a depth of 36 inches from December to June and are dry from June to November in most years. Vegetation is annual grasses, forbs, and a few scattered oaks.

In a representative profile the surface layer is grayish-brown, neutral and slightly acid loam about 25 inches thick. The substratum is brown, slightly acid loam and heavy loam that extends to a depth of more than 60 inches.

Permeability is moderate, and the available water capacity is 9 to 10 inches. Roots can penetrate to a depth of 60 inches.

Garretson soils are used for homesites and recreation areas.

Representative profile of Garretson loam, 2 to 5 percent slopes, on an alluvial fan in NW¼SW¼ sec. 20, T. 1 N., R. 1 W. (projected).

Ap—0 to 4 inches, grayish-brown (10YR 5/2) loam, dark brown (10YR 3/3) when moist; massive; hard, friable, slightly sticky and slightly plastic; many very fine roots; common, very fine and fine, interstitial pores; neutral; clear, smooth boundary.

A12—4 to 25 inches, grayish-brown (10YR 5/2) loam, dark brown (10YR 3/3) when moist; massive; hard, friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; many, very fine and few, medium, tubular pores; slightly acid; gradual, wavy boundary.

C1—25 to 38 inches, brown (10YR 5/3) loam, dark brown (10YR 3/3) when moist; massive; hard, friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; many, very fine and fine and few, medium, tubular pores; slightly acid; gradual, wavy boundary.

C2—38 to 48 inches, brown (10YR 5/3) heavy loam, dark brown (10YR 3/3) when moist; massive; hard, friable, slightly sticky and slightly plastic; common very fine and fine and many medium roots; many, very fine and few, medium, tubular pores; slightly acid; clear, wavy boundary.

C3—48 to 60 inches, brown (7.5YR 5/4) heavy loam, dark brown (7.5YR 4/4) when moist; massive; hard, very friable, slightly sticky and slightly plastic; few very fine and fine and common medium roots; many, very fine and fine and few, medium, tubular pores; slightly acid.

The A horizon is 22 to 28 inches thick. It is grayish brown, dark brown, or brown in a hue of 10YR. It is loam or light clay loam.

The C horizon is typically loam, but in a few places the lower part is stratified with lenses of fine sand less than 2 inches thick. The C horizon is brown or yellowish brown and is slightly acid to mildly alkaline.

GaA—Garretson loam, 0 to 2 percent slopes. This nearly level soil is on flood plains of small creeks. Included with it in mapping are areas on Conejo clay loam that make up about 10 percent of the mapping unit and areas of Botella clay loam that make up 5 percent.

Runoff is very slow to slow, and the hazard of erosion is none to slight where the soil is tilled and exposed.

This soil is used mainly for homesites. A few areas are used for dryland walnuts. Capability unit I (17).

GaB—Garretson loam, 2 to 5 percent slopes. This gently sloping soil is on alluvial fans. It has the profile described as representative of the series.

Included with this soil in mapping are areas of Conejo clay loam that make up about 10 percent of the mapping unit and areas of Briones fine sandy loam that make up 5 percent.Also included are some areas of Garretson soils that have slopes of 5 to 9 percent.

Runoff is slow, and the hazard of erosion is slight where the soil is tilled and exposed.

This soil is used for homesites and recreation areas. Capability unit IIe–1 (17).

Gaviota Series

The Gaviota series consists of well-drained and somewhat excessively drained soils underlain by sandstone. These soils are on uplands. Slopes are 15 to 75 percent. Elevation ranges from 100 to 2,500 feet. The average annual air temperature is 59° F., and the frost-free season is 260 to 300 days. The average annual rainfall is 14 to 25 inches. These soils are moist from October to April and are dry from May to November in most years. Vegetation is annual grasses, forbs, and some oaks. Dense stands of coyote bush, chamise, and scattered oaks are in some areas.

In a representative profile the surface layer is grayish-brown and brown, slightly acid sandy loam. It is underlain at a depth of 17 inches by white and brownish-yellow sandstone.

Permeability is moderately rapid, and the available water capacity is 1.5 to 3 inches. Roots can penetrate to a depth of 10 to 20 inches.

Gaviota soils are used for range, wildlife habitat, and watershed.

Representative profile of Gaviota sandy loam, 30 to 50 percent slopes, on a north-facing slope in NE¼NW¼NW¼ sec. 10, T. 1 N., R. 1 W. (projected).

A11—0 to 3 inches, grayish-brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; slightly hard, very friable, nonsticky and nonplastic; many very fine roots; many, very fine, interstitial pores and few, fine, tubular pores; slightly acid; clear, wavy boundary.

A12—3 to 11 inches, grayish-brown (10YR 5/2) sandy loam, dark grayish brown (10YR 4/2) when moist; massive; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine roots; common, very fine and fine, tubular pores; slightly acid; gradual, wavy boundary.

A13—11 to 17 inches, brown (10YR 5/3) light sandy loam, brown (10YR 4/3) when moist; massive; slightly hard, very friable, nonsticky and nonplastic; common very fine and many fine and medium roots; common, very fine and fine, tubular pores; slightly acid; abrupt, irregular boundary.

R—17 to 22 inches, white (10YR 8/2) and brownish-yellow (10YR 6/6) sandstone; fine, medium, and coarse roots along cleavage planes; upper 1 inch is soft; strongly acid.

The A horizon is grayish brown, brown, or pale brown. It is slightly acid or neutral. The A horizon is generally massive, but in places it has granular structure in the upper 2 to 4 inches.

Depth to sandstone ranges from 10 to 20 inches.

GbE—Gaviota sandy loam, 15 to 30 percent slopes. This hilly soil is on uplands. Included with it in mapping are areas of Briones loamy sand that make up about 10 percent of the mapping unit and areas of Millsholm loam that make up 5 percent. Also included are a few areas of gently rolling to rolling soils.

This soil is well drained. Runoff is medium to rapid, and the hazard of erosion is moderate to high where the soil is bare.

This soil is used for range. Capability unit VIIe–1 (15); Shallow Coarse Loamy range site.

GbF—Gaviota sandy loam, 30 to 50 percent slopes. This steep soil is on uplands. It has the profile described as representative of the series.

Included with this soil in mapping are areas of Briones loamy sand that make up about 5 percent of the mapping unit and areas of Millsholm loam that make up 5 percent. Also included are outcrops of sandstone that make up as much as 5 percent.

This soil is well drained. Runoff is rapid, and the hazard of erosion is high where the soil is bare.

This soil is used for range. Capability unit VIIe–1 (15); Shallow Coarse Loamy range site.

GbG—Gaviota sandy loam, 50 to 75 percent slopes. This soil is very steep. Included with it in mapping are areas of Millsholm loam that make up about 5 percent of the mapping unit. Also included are outcrops of sandstone that make up as much as 10 percent.

This soil is somewhat excessively drained. Runoff is rapid, and the hazard of erosion is high.

This soil is used for range, wildlife habitat, and watershed. Capability unit VIIe–1 (15); Shallow Coarse Loamy range site, steep.

Gilroy Series

The Gilroy series consists of well-drained soils underlain by basic igneous rock. These soils are on uplands. Slopes are 15 to 75 percent. Elevation ranges from 500 to 1,500 feet. The average annual air temperature is 57° F., and the frost-free season is 260 to 300 days. The average annual rainfall is 15 to 25 inches. These soils are moist from mid-December to May and are dry from June to mid-October in most years. Vegetation is annual grasses, forbs, and oak. Oak, grass, digger pine, and some thick stands of poison oak are on some of the very steep slopes.

In a representative profile the surface layer is reddish-brown, slightly acid light clay loam about 15 inches thick. The upper part of the subsoil is reddish-brown, slightly acid clay loam about 14 inches thick. The lower part is reddish-brown, slightly acid very gravelly loam about 11 inches thick. It is underlain by basic igneous rock at a depth of 40 inches.

Permeability is moderately slow, and the available water capacity is 4 to 7 inches. Roots can penetrate to a depth of 20 to 40 inches.

Gilroy soils are used for range, wildlife habitat, recreation areas, and watershed.

Representative profile of Gilroy clay loam, 30 to 50 percent slopes, on a north-facing slope ½ mile south of Clayton in SW¼SW¼ sec. 14, T. 1 N., R. 1 W.

A1—0 to 15 inches, reddish-brown (5YR 4/3) light clay loam, dark reddish brown (5YR 3/3) when moist; moderate, fine and medium, granular structure; hard, friable, sticky and plastic; common fine and very fine and few medium and coarse roots; common, fine and very fine, tubular and interstitial pores; slightly acid; gradual, wavy boundary.

B2t—15 to 29 inches, reddish-brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) when moist; moderate, fine and medium, subangular blocky structure; hard, friable, sticky and plastic; few fine, medium, and coarse roots; common, fine and very fine, tubular and interstitial pores; common thin clay films lining pores and on ped faces; slightly acid; clear, wavy boundary.

B3t—29 to 40 inches, reddish-brown (5YR 4/4) very gravelly loam, dark reddish brown (5YR 3/4) when moist; moderate, medium and coarse, angular blocky structure; very hard, firm, sticky and plastic; very few medium and coarse roots; very few tubular pores; many moderately thick clay films on gravel and ped faces; slightly acid; abrupt, irregular boundary.

R—40 to 49 inches, basic igneous rock; clay films on rock surfaces.

The A horizon is 8 to 16 inches thick. It is reddish brown, brown, or dark brown in hues of 5YR and 7.5YR, value of 3 or 4, and chroma of 2 or 3.

The B2t horizon is 6 to 14 inches thick. It is reddish brown, dark reddish brown, or dark brown in hues of 5YR and 7.5YR. The B3t horizon is reddish brown, brown, or strong brown in hues of 5YR and 7.5YR. It is gravelly or very gravelly loam, clay loam, or light clay.

Depth to bedrock ranges from 20 to 40 inches.

GcE—Gilroy clay loam, 15 to 30 percent slopes. This moderately steep soil is on uplands. Included with it in mapping are areas of Los Gatos loam that make up about 10 percent of the mapping unit and areas of Vallecitos loam that make up 5 percent.

Runoff is medium, and the hazard of erosion is moderate where the soil is bare. Roots can penetrate to a depth of 30 to 40 inches. The available water capacity is 4.5 to 6.0 inches.

This soil is used mainly for range, but a few areas are used for dryland small grain. Capability unit IVe–1 (15); Loamy range site.

GcF—Gilroy clay loam, 30 to 50 percent slopes. This steep soil is on uplands. It has the profile described as representative of the series.

Included with this soil is mapping are areas of Vallecitos loam that make up about 4 percent of the mapping unit and rock outcrops that make up 5 percent. Also included are areas of a deep soil that has a surface layer of dark-brown clay loam and a subsoil of yellowish-brown clay. These areas make up 2 percent of the mapping unit.

Runoff is medium to rapid, and the hazard of erosion is moderate to high. Roots can penetrate to a depth of 20 to 40 inches. The available water capacity is 3 to 6 inches.

This soil is used for range, recreation areas, wildlife habitat, and watershed. Capability unit VIe–1 (15); Loamy range site, steep.

GcG—Gilroy clay loam, 50 to 75 percent slopes. This very steep soil is on uplands. Included with it in mapping are rock outcrops that make up as much as 8

percent of the mapping unit. Also included are areas of a slightly acid loam soil that is underlain by basic igneous rock at a depth of less than 20 inches. These areas make up 7 percent of the mapping unit.

Runoff is rapid, and the hazard of erosion is high where the soil is bare. Roots can penetrate to a depth of 20 to 30 inches. The available water capacity is 3 to 4.5 inches.

This soil is used for range, recreation areas, wildlife habitat, and watershed. Capability unit VIIe–1(15); Loamy range site, very steep.

Joice Series

The Joice series consists of very poorly drained soils. These soils are in brackish marshes affected by tides. Slopes are less than 1 percent. Elevation ranges from 0 to 5 feet below sea level. The average annual soil temperature is 59° to 60° F., and the frost-free season is 260 to 300 days. The average annual precipitation is 12 to 16 inches. Vegetation is saltgrass, sedges, and pickleweed.

In a representative profile the surface layer is dark-brown, strongly acid muck 5 inches thick. Below that is black, very strongly acid muck about 17 inches thick. The next layer is very dark brown, very strongly acid muck about 12 inches thick. It is underlain by dark grayish-brown, strongly acid muck that has a high content of polysulphides and that extends to a depth of 60 inches.

The water table is generally between depths of 12 and 36 inches. The soils are subject to saltwater intrusion, especially during very high tides which cause the water table to rise to the surface. They are also subject to freshwater flooding. Permeability is moderate, and the available water capacity is about 4 to 10 inches. Upon drying, the soils shrink irreversibly. They are strongly affected by salt.

Joice soils are used mainly for saltgrass pasture. They are also used for wildlife habitat and as a buffer zone between the Suisun Bay and higher areas.

Representative profile of Joice muck in a tidal marsh, about 300 feet north of the Mallard Pumping Station north of Ambrose in SW¼NE¼NW¼ sec. 12, T. 2 N., R. 1 W. (projected). (Color is for moist soil unless otherwise noted; pH by 0.01 M $CaCl_2$ for organic layers.)

Oa1—0 to 5 inches, dark-brown (10YR 3/3) muck, dark grayish brown (10YR 4/2) when dry; no undisturbed fibers; medium, very fine, granular structure; nonsticky and nonplastic; many, very fine and fine roots; evidence of having been burned; strongly acid; abrupt, smooth boundary.

Oa2—5 to 15 inches, black (10YR 2/1) muck, black (10YR 2/1) when rubbed; less than 5 percent undisturbed fibers, none when rubbed; weak, very fine, granular structure; nonsticky and nonplastic; many, very fine and fine and common, medium roots; very strongly acid; clear, smooth boundary.

Oa3—15 to 22 inches, black (10YR 2/1) muck, black (10YR 2/1) when rubbed; less than 5 percent undisturbed fibers, none when rubbed; massive; slightly sticky and slightly plastic; common fine and medium roots; very strongly acid; gradual, smooth boundary.

Oa4—22 to 34 inches, very dark brown (10YR 2/2) muck, very dark brown (10YR 2/2) when rubbed; dark yellowish-brown (10YR 3/4) fibers; about 30 percent undisturbed fibers, 5 percent when rubbed; pockets about 3 inches in diameter that are 50 percent undisturbed fibers, 10 percent when rubbed; weak, medium, subangular blocky structure; very slightly sticky and very slightly plastic; very strongly acid; clear, smooth boundary.

Oa5—34 to 60 inches, dark grayish-brown (2.5Y 4/2) muck, dark grayish brown (2.5Y 4/2) when rubbed; dark yellowish-brown (10YR 4/4) fibers; about 30 percent undisturbed fibers, 5 percent when rubbed; strong odor of hydrogen sulfide; massive; very slightly sticky and very slightly plastic; strongly acid.

The Oa1 horizon ranges in color from 10YR 5/2 to 10YR 3/3 or 4/2 if burned and to 10YR 2/1 if not burned. The Oa2 and Oa3 horizons are black or very dark brown (10YR 2/1 or 2/2). The upper three horizons have weak, very fine to medium, granular or fine, subangular blocky structure, or they are massive. The content of undisturbed fibers is less than 20 percent, and the content of fibers is less than 5 percent after rubbing. The Oa1, Oa2, and Oa3 horizons are very strongly acid or strongly acid.

The Oa4 horizon ranges in color from 7.5YR 2/2 to 2/5Y 2/2 and contains yellowish-brown fibers. The content of undisturbed fibers is less than 40 percent, and the content of fibers is less than 10 percent after rubbing. The Oa4 horizon has pockets of fibers in some places. It has an odor of hydrogen sulfide in places.

The Oa5 horizon ranges from dark grayish brown to olive gray (2.5Y 4/2 and 3/2 to 5Y 4/2 and 3/2) and has dark yellowish-brown fibers. Its fiber content is slightly less than that of the Oa4 horizon in places. The Oa4 horizon is very strongly acid to medium acid.

Cracks 4 to 7 inches wide and 24 inches deep are at intervals of 4 to 7 feet. Smaller cracks 1 to 2 inches wide and 24 inches deep are between the large cracks. The water table fluctuates between depths of 12 and 36 inches. The organic-matter content changes irregularly with depth but averages slightly less than 45 percent between depths of 12 and 52 inches.

Ja—Joice muck. This nearly level soil formed in saltwater marshes. It is the only Joice soil mapped in the county.

Included with this soil in mapping are areas of Reyes silty clay, commonly near tidal flats, that make up about 8 percent of the mapping unit. These areas are subject to more saltwater intrusion than Joice muck. Also included are areas of a soil that is similar to Joice muck except that its organic-matter content averages more than 45 percent between depths of 12 and 52 inches.

Joice muck is subject to ponding, or surface water runs off very slowly. There is no hazard of erosion.

This soil is used mainly for pasture. It is also used for wildlife habitat. Capability unit VIw–1(16).

Kimball Series

The Kimball series consists of well-drained soils underlain by weakly cemented, gravelly terrace material. These soils are on old terraces. Slopes are 2 to 30 percent. Elevation ranges from 100 to 600 feet. The average annual air temperature is 59° F., and the frost-free season is 260 to 300 days. The average annual rainfall is 14 to 16 inches. These soils are moist in the upper 20 inches from December to April and are dry from May to November in most years. Vegetation is annual grasses, forbs, and a few scattered oaks.

In a representative profile the surface layer is brown and dark-brown, neutral gravelly light clay loam about 15 inches thick. The subsoil is brown and yellowish-red, mildly alkaline or moderately alkaline gravelly clay and clay. It is underlain at a depth of about 45 inches by a substratum of yellowish-red, weakly cemented, calcareous gravelly sandy clay loam.

Permeability is very slow, and the available water capacity is 3 to 5 inches. Some moisture available to plants stands above the clayey subsoil. Roots can penetrate to a depth of 10 to 20 inches.

Kimball soils are used mainly for range. A few small areas are used for dryland small grain and irrigated apricots and cherries.

Representative profile of Kimball gravelly clay loam, 2 to 9 percent slopes, in an orchard in SE¼SE¼NW¼NW¼ sec. 14, R. 2 E., T. 1 N.

Ap—0 to 5 inches, brown (10YR 4/3) gravelly light clay loam, dark brown (7.5YR 3/2) when moist; massive; very hard, firm, sticky and plastic; few fine and very fine roots; many, very fine, tubular pores; neutral; clear, smooth boundary.

A12—5 to 15 inches, dark-brown (7.5YR 4/2) gravelly light clay loam, dark brown (7.5YR 3/2) when moist; massive; very hard, firm, sticky and plastic; few very fine and fine and common medium roots; common, very fine, tubular pores; neutral; abrupt, wavy boundary.

B21t—15 to 26 inches, brown (7.5YR 4/4) gravelly clay, reddish brown (5YR 4/3) when moist; weak, coarse, prismatic structure parting to moderate, medium, angular blocky; extremely hard, extremely firm, very sticky and very plastic; few very fine and common, medium, exped roots; few, very fine, tubular pores; continuous moderately thick clay films on ped faces and lining pores; mildly alkaline; clear, wavy boundary.

B22t—26 to 35 inches, yellowish-red (5YR 5/6) clay, yellowish brown (5YR 4/6) when moist; moderate, medium, angular blocky structure; extremely hard, extremely firm, very sticky and very plastic; very few, very fine, fine, and medium, exped roots; very few, very fine, tubular pores; continuous moderately thick clay films in pores and on ped faces; moderately alkaline; very slightly effervescent; lime in soft masses; clear, wavy boundary.

B3tca—35 to 45 inches, yellowish-red (5YR 5/6) gravelly clay, yellowish red (5YR 4/6) when moist; weak, moderate, angular blocky structure; extremely hard, extremely firm, sticky and plastic; many thick clay films and clay oriented as bridges; moderately alkaline; slightly effervescent; lime in soft masses; gradual, wavy boundary.

C—45 to 60 inches, yellowish-red (5YR 5/6) gravelly sandy clay loam, yellowish red (5YR 4/6) when moist; massive; extremely hard, extremely firm, slightly sticky and slightly plastic; moderately alkaline; very slightly effervescent.

The A horizon is 10 to 20 inches thick. It is brown, dark-brown, or very dark brown gravelly loam or gravelly light clay loam. It is slightly acid or neutral.

The B2t horizon is brown, dark brown, or reddish brown in the upper part and yellowish red, reddish brown, or brown in the lower part. It has a few slickensides or pressure faces. It is neutral to moderately alkaline and is calcareous in the lower part in a few places.

The C horizon is yellowish red and reddish brown or brown and is neutral to moderately alkaline. It is calcareous in places.

Gravel content ranges from none to 20 percent, by volume, throughout the solum.

KaC—Kimball gravelly clay loam, 2 to 9 percent slopes. This gently sloping to moderately sloping soil is on terraces. It has the profile described as representative of the series.

Included with this soil in mapping are areas of Perkins gravelly loam that make up about 8 percent of the mapping unit, areas of Positas loam that make up 5 percent, and areas of Rincon clay loam that make up 2 percent. Also included are about 45 acres of nearly level soil.

Runoff is slow to medium, and the hazard of erosion is slight to moderate where the soil is tilled and exposed.

This soil is used mainly for range, dryland small grain, and irrigated apricots and cherries. Capability unit IVe–3 (15); Claypan range site.

KaE—Kimball gravelly clay loam, 9 to 30 percent slopes. This strongly sloping to moderately steep soil is on terraces. Included with it in mapping are areas of Perkins gravelly clay loam that make up about 12 percent of the mapping unit. Also included are areas of very gravelly, slightly acid loam about 4 feet deep over weakly cemented terrace material that make up 3 percent.

Runoff is medium, and the hazard of erosion is moderate where the soil is bare.

This soil is used for range. Capability unit VIe–1 (15); Claypan range site.

Kingile Series

The Kingile series consists of very poorly drained soils in fresh-water marshes and old river channels. Slopes are less than 2 percent. Elevation ranges from 10 to 15 feet below sea level. The average annual air temperature is 60° F., and the frost-free season is 260 to 300 days. The average annual rainfall is 12 to 14 inches. Vegetation is tules and reeds.

In a representative profile the surface layer is black, medium acid muck about 11 inches thick. Below this is very dark brown, strongly acid muck. It is underlain at a depth of 20 inches by a substratum of very dark gray and dark-gray, medium acid silty clay.

Permeability is rapid in the muck layer and slow in the mineral substratum. The available water capacity is 6 to 10 inches. The water table has been lowered to a depth of 3 to 5 feet by open drains and pumping. It fluctuates to within 1 foot of the surface in winter. Roots can penetrate to a depth of 16 to 36 inches.

Kingile soils are used for irrigated field corn, asparagus, milo, and tomatoes. These soils are flooded in winter after annual crops are harvested.

Representative profile of Kingile muck, northwest of where Indian Slough meets the Old River at the center point of NE¼NE¼ sec. 10 (projected) T. 1 N., R. 4 E. (Color is for moist soil unless otherwise noted; pH by 0.01M $CaCl_2$ for organic layers.)

Oap—0 to 4 inches, black (10YR 2/1) muck, black (10YR 2/1) when rubbed, very dark grayish brown (10YR 3/2) when dry; trace of undisturbed fibers, none when rubbed; weak, fine, granular structure; nonsticky and slightly plastic; medium acid; abrupt, smooth boundary.

Oa2—4 to 11 inches, black (10YR 2/1) muck, black (10YR 2/1) when rubbed; trace of fibers, none when rubbed; weak, moderate, subangular blocky structure parting to moderate, medium, granular; nonsticky and slightly plastic; contain small pockets

of organic fibers; medium acid; clear, smooth boundary.

Oa3—11 to 15 inches, variegated very dark brown (10YR 2/2) and dark reddish-brown (5YR 2/2) muck, black (10YR 2/1) when rubbed; less than 5 percent undisturbed fibers, none when rubbed; moderate, medium, platy structure; slightly sticky and slightly plastic; strongly acid; clear, smooth boundary.

Oa4—15 to 20 inches, variegated very dark brown (10YR 2/2) and very dark grayish-brown (10YR 3/1) muck; common, medium, distinct, reddish-brown (5YR 4/4) masses of fibers, black (10YR 2/1) when rubbed; less than 10 percent undisturbed fibers, trace of fibers when rubbed; moderate, medium, platy structure; slightly sticky and slightly plastic; strongly acid; abrupt, smooth boundary.

IIC1—20 to 26 inches, very dark gray (10YR 3/1) silty clay; trace of organic fibers; massive; hard, firm, sticky and plastic; contain a 1-inch lens of 20 percent fibers, trace of fibers after rubbing, at bottom of horizon; medium acid; gradual, smooth boundary.

IIC2—26 to 60 inches, dark-gray (10YR 4/1) silty clay; massive; hard, firm, sticky and plastic; medium acid.

The Oap horizon is black (10YR 2/1), very dark gray (10YR 3/2), or very dark brown (10YR 2/2). It contains none to less than 5 percent undisturbed organic fibers and ranges from pH 5.0 to 6.0.

The Oa2 horizon is variegated or mottled, depending on time of saturation. It contains from less than 5 percent to 20 percent undisturbed fibers and none to 10 percent fibers when rubbed. The Oa2 and Oa3 horizons range from pH 4.5 to 6.0. The Oa3 horizon in some places has the distinct color difference of fiber masses as described. Either the Oa2 or Oa3 horizon has thin strata or pockets of light-brown or light-gray ash in places.

The IIC1 horizon contains as much as 15 percent organic fibers scattered throughout the horizon in places. The IIC2 horizon has gleyed colors in places. Strata of organic material less than ½ inch thick occur at a depth of more than 26 inches. The IIC1 horizon contains as much as 15 percent mica fragments in the mineral part in places.

Depth to the mineral layer ranges from 16 to 36 inches. The organic part ranges from 30 to 50 percent organic matter and is derived from tules and reeds. The clay fraction of the mineral part is mixed.

Kb—Kingile muck. This is the only Kingile soil mapped in the county. Included with it in mapping are Egbert mucky clay loam and Webile muck that each make up about 5 percent of the mapping unit and Shima muck and Venice muck that each make up 3 percent. Also included, especially in the southern part of the Orwood Tract, are small areas of a soil that is similar to Kingile muck except that it has an organic layer below a depth of 30 inches and is underlain by clay or silty clay below a depth of 40 inches.

Kingile muck is subject to ponding, or water runs off very slowly. There is no hazard of water erosion, but soil blowing is a moderate hazard where the soil is tilled and exposed.

This soil is used for irrigated field corn, asparagus, milo, and tomatoes. Capability unit IIIw–10 (16).

Laugenour Series

The Laugenour series consists of poorly drained soils that formed in recent alluvium from sedimentary rock. Slopes are 0 to 2 percent. Elevation ranges from 10 to 300 feet. The average annual air temperature is 59° F., and the frost-free season is 250 to 300 days. The average annual rainfall is 14 to 18 inches. Vegetation is annual grasses and forbs.

In a representative profile the surface layer is grayish-brown, calcareous loam about 14 inches thick. The substratum, to a depth of 30 inches, is mottled, grayish-brown, brown, and dark-brown, stratified silty clay loam, fine sandy loam, and silt loam. Below this it is grayish-brown loamy sand and sand to a depth of 60 inches.

Permeability is moderate in the upper part of the soil and rapid in the permeable substratum. The available water capacity is 5 to 9.5 inches. Artificial drainage has lowered the water table to a depth of 5 feet or more in most areas. Roots can penetrate to a depth of 40 to more than 60 inches.

Laugenour soils are used mainly for commercial development. A few areas are used for irrigated almonds.

Representative profile of Laugenour loam, northeast of the junction of Willow Pass Road and Contra Costa Boulevard.

Ap—0 to 4 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; massive; hard, friable, slightly sticky and slightly plastic; many very fine roots; common, very fine, tubular and interstitial pores; moderately alkaline; very slightly effervescent; lime is disseminated and in fine soft masses; gradual, smooth boundary.

A12—4 to 14 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine roots; many, very fine, tubular pores; moderately alkaline; very slightly effervescent; lime is disseminated and in fine soft masses; clear, wavy boundary.

C—14 to 20 inches, mottled grayish-brown (2.5Y 5/2) and brown (10YR 5/3) light silty clay loam, very dark brown (10YR 2/2) and dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; hard, friable, sticky and slightly plastic; many fine roots; many, very fine, tubular pores; moderately alkaline; strongly effervescent; lime is disseminated and in seams; clear, wavy boundary.

IIC2—20 to 28 inches, mottled grayish-brown (2.5Y 5/2) and dark-brown (10YR 4/3) fine sandy loam, dark grayish brown (10YR 4/2) and black (2.5Y 2/2) when moist; massive; slightly hard, very friable, slightly sticky and nonplastic; many very fine roots; many, very fine, tubular pores; moderately alkaline; slightly effervescent; lime is disseminated; abrupt, wavy boundary.

IIIC3—28 to 30 inches, faintly mottled, grayish-brown (2.5Y 5/2) silt loam, very dark grayish brown (2.5Y 3/2) when moist; weak, medium, subangular blocky structure; hard, friable, sticky and slightly plastic; many very fine roots; many, very fine, tubular pores; moderately alkaline; strongly effervescent; lime is disseminated; gradual, smooth boundary.

IVC4—30 to 39 inches, grayish-brown (2.5Y 5/2) loamy sand, dark grayish brown (2.5Y 4/2) when moist; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; common, very fine, tubular pores; moderately alkaline; gradual, smooth boundary.

IVC5—39 to 60 inches, grayish-brown (2.5Y 5/2) sand, dark grayish brown (2.5Y 4/2) when moist; single grained; loose, nonsticky and nonplastic; few very fine roots; many interstitial pores; moderately alkaline.

The A horizon is 12 to 18 inches thick. It is pale brown, grayish brown, light grayish brown, or brown and is fine sandy loam, loam, silt loam, or light silty clay loam.

The C horizon is stratified and is sand to silty clay loam. The upper part of the C horizon has prominent or distinct mottles.

These soils are calcareous between depths of 10 and 20 inches. The organic-matter content is less than 1 percent and decreases irregularly with depth.

La—Laugenour loam. This is the only Laugenour soil mapped in the county. Included with it in mapping are Sycamore silty clay loam and Omni clay loam that each make up about 5 percent of the mapping unit. Also included are a few areas of a soil that is underlain by clay at a depth of 40 inches.

Runoff is slow, and there is no hazard of erosion where the soil is tilled and exposed.

This soil is used mainly for commercial development. A few acres are used for irrigated almonds. Capability unit IIs–0(17).

Linne Series

The Linne series consists of well-drained soils underlain by calcareous, interbedded shale and soft sandstone. These soils are on lower foothills in the eastern part of the county. Slopes are 5 to 30 percent. Elevation ranges from 150 to 1,000 feet. The average annual air temperature is 59° F., and the frost-free season is 260 to 300 days. The average annual rainfall is 12 to 15 inches. These soils are moist between depths of 4 and 20 inches from late in December to April and are dry from May to November in most years. Vegetation is annual grasses and forbs.

In a representative profile the surface layer is gray, calcareous clay loam about 29 inches thick. It is underlain by white, calcareous shale.

Permeability is moderately slow, and the available water capacity is 4 to 8 inches. Roots can penetrate to a depth of 20 to 40 inches.

Linne soils are used for range, for dryland grain, chiefly barley, and for volunteer hay.

Representative profile of Linne clay loam, 5 to 15 percent slopes, along Camino Diablo Road in NE¼SE¼NW¼ sec. 8, T. 1 S., R. 3 E.

A11—0 to 12 inches, gray (10YR 5/1) clay loam, very dark gray (10YR 3/1) when moist; moderate, fine and medium, granular structure; slightly hard, very friable, sticky and plastic; many very fine roots; many, very fine and fine, interstitial pores; moderately alkaline; strongly calcareous; few filaments and soft bodies of lime; diffuse, wavy boundary.

A12ca—12 to 29 inches, gray (10YR 5/1) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine and medium, granular structure; slightly hard, very friable, sticky and plastic; many very fine roots; many, very fine and fine, interstitial pores; moderately alkaline; strongly calcareous, many irregularly shaped lime concretions; abrupt, wavy boundary.

Crca—29 to 32 inches, white (10YR 8/1) shale; calcareous; many filaments and coatings of lime.

The A horizon is gray, dark gray, or very dark gray and is heavy loam, silt loam, clay loam, or light silty clay loam. It has moderate or strong, fine or medium, granular structure.

The profile is mildly calcareous to strongly calcareous. In some places, the uppermost few inches do not effervesce.

Depth to soft, interbedded sedimentary rock is 20 to 40 inches.

LbD—Linne clay loam, 5 to 15 percent slopes. This gently rolling to rolling soil is on foothills in the uplands. It has the profile described as representative of the series.

Included with this soil in mapping are Fontana silty clay loam and Diablo clay that each make up about 5 percent of the mapping unit. Also included are areas of gray, calcareous clay loam that is 10 to 20 inches deep to interbedded sedimentary rock. These areas make up 4 percent of the mapping unit. Areas of gravelly clay loam less than 10 inches deep that formed in soft conglomerate make up 1 percent.

Runoff is slow to medium, and the hazard of erosion is slight to moderate where the soil is tilled and exposed.

This soil is used for dryland grain, chiefly barley, and for range. Capability unit IIIe–5(15); Clayey range site.

LbE—Linne clay loam, 15 to 30 percent slopes. This soil is moderately steep. Included with it in mapping are areas of dark-gray, calcareous clay loam that is 10 to 20 inches deep to interbedded sedimentary rock. These areas make up about 8 percent of the mapping unit. Also included are areas of Fontana silty clay loam that make up 5 percent. Areas of a soil that is similar to Linne clay loam but that is noncalcareous throughout the surface layer make up 2 percent.

Runoff is medium, and the hazard of erosion is moderate where the soil is bare.

This soil is used for range and some dryland grain, chiefly barley. Capability unit IVe–1(15); Clayey range site.

Lodo Series

The Lodo series consists of somewhat excessively drained soils underlain by soft sandstone and shale. These soils are on uplands (fig. 5). Slopes are 9 to 75 percent. Elevation ranges from 300 to 3,000 feet. The average annual air temperature is 59° F., and the frost-free season is 260 to 300 days. The average annual rainfall is 14 to 25 inches. These soils are moist from a depth of 4 inches to bedrock from November to May and are dry from June to November in most years. Vegetation is annual grasses, forbs, and oak. Dense stands of oak are in a few areas.

In a representative profile the surface layer is dark-gray, slightly acid clay loam about 18 inches thick. It is underlain by fine-grained sandstone.

Permeability is moderately slow, and the available water capacity is 2 to 4 inches. Roots can penetrate to a depth of 10 to 20 inches.

Lodo soils are used for range, wildlife habitat, and watershed.

Representative profile of Lodo clay loam, 9 to 30 percent slopes, north of Livorna Road in SE¼SE¼SE¼ sec. 1, T. 1 N., R. 1 W.

A11—0 to 6 inches, dark-gray (10YR 4/1) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, subangular blocky structure; very hard, friable, slightly sticky and plastic; many very fine and few fine roots; many, fine and few,

Figure 5.—**Lodo soils on uplands. Slope ranges from 9 to 75 percent.**

medium, tubular pores; slightly acid; gradual, smooth boundary.

A12—6 to 18 inches, dark-gray (10YR 4/1) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, subangular blocky structure; very hard, friable, slightly sticky and plastic; common very fine roots; common, fine, tubular pores; slightly acid; abrupt, wavy boundary.

R—18 to 22 inches, light-gray (2.5Y 7/2) fine-grained sandstone.

The A horizon is dark gray, grayish brown, very dark grayish brown, brown, or dark brown. It has hues of 10YR, 2.5Y, or 7.5YR and moist values and chromas of 3 or less. The A horizon is clay loam or loam. It has weak or moderate, fine or medium, granular or fine, subangular blocky structure and ranges from medium acid to neutral.

Depth to shale or sandstone is 10 to 20 inches. The R layer is between 3 to 4 in hardness on the Mohs scale.

LcE—Lodo clay loam, 9 to 30 percent slopes. This rolling to hilly soil is on uplands. It has the profile described as representative of the series.

Included with this soil in mapping are Los Osos clay loam and Millsholm loam, each of which makes up about 5 percent of the mapping unit, and areas of Tierra loam that make up 3 percent. Also included are rock outcrops that make up 2 percent and small areas of gently rolling Lodo soil.

Runoff is medium to rapid and the hazard of erosion is moderate to high where the soil is bare.

This soil is used for range. Capability unit VIe–1 (15); Shallow Fine Loamy range site.

LcF—Lodo clay loam, 30 to 50 percent slopes. This steep soil is on uplands. Included with it in mapping are areas of Millsholm soils that make up about 10 percent of the mapping unit and areas of Gaviota sandy loam that make up 2 percent. Also included are rock outcrops that make up 3 percent.

Runoff is medium to rapid, and the hazard of erosion is moderate to high where the soil is bare.

This soil is used for range, wildlife habitat, and watershed. Capability unit VIIe–1 (15); Shallow Fine Loamy range site, steep.

LcG—Lodo clay loam, 50 to 75 percent slopes. This very steep soil is on uplands. Included with it in mapping are rock outcrops that make up about 8 percent of the mapping unit and areas of Millsholm loam that make up 7 percent.

Runoff is rapid, and the hazard of erosion is high where the soil is bare.

This soil is used for range, wildlife habitat, and watershed. Capability unit VIIe–1 (15); Shallow Fine Loamy range site, very steep.

Ld—Lodo-Rock outcrop complex. This complex consists of about 60 percent Lodo clay loam and about 25 percent sandstone outcrops. Slopes are 15 to 75 percent.

Runoff is medium to very rapid, and the hazard of erosion is moderate to very high where the Lodo soil is bare.

This complex is used for range, wildlife habitat, and watershed. Capability unit VIIe–1 (15); Shallow Fine Loamy range site, very steep.

Los Gatos Series

The Los Gatos series consists of well-drained soils underlain by interbedded sedimentary rock. These soils are on north-facing slopes in the uplands. Slopes are 15 to 75 percent. Elevation ranges from 500 to 2,000 feet. The average annual air temperature is 56° F., and the frost-free season is 260 to 300 days. The

average annual rainfall is 18 to 25 inches. These soils are moist from December to July and are dry from July to November in most years. Vegetation is annual grasses, forbs, and oak. Dense stands of oak, laurel, California buckeye, and poison-oak and an understory of scattered annual grasses and forbs are in some areas.

In a representative profile the surface layer is brown, slightly acid heavy loam about 8 inches thick. The subsoil is brown, medium acid light clay loam in the upper 4 inches and reddish-brown, medium acid clay loam in the lower 15 inches. Sandstone bedrock is at a depth of about 27 inches.

Permeability is moderately slow, and the available water capacity is 3.5 to 6 inches. Roots can penetrate to a depth of 20 to 40 inches.

Los Gatos soils are used for range, wildlife habitat, and watershed.

Representative profile of Los Gatos loam, 30 to 50 percent slopes, on a north-facing slope in SE¼SE¼ NW¼ sec. 7, T. 1 S., R. 3 E.

A1—0 to 8 inches, brown (7.5YR 5/4) heavy loam, dark brown (7.5YR 3/2) when moist; moderate, fine and medium, granular structure; hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; common, very fine, tubular pores and many, very fine, interstitial pores; slightly acid; clear, wavy boundary.

B1—8 to 12 inches, brown (7.5YR 4/4) light clay loam, dark reddish brown (5YR 3/3) when moist; moderate, medium, subangular blocky structure parting to moderate, fine, granular; hard, friable, sticky and slightly plastic; many very fine and fine roots; many, very fine and common, fine, tubular pores; medium acid; gradual, wavy boundary.

B21t—12 to 21 inches, reddish-brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) when moist; moderate, coarse, subangular blocky structure; hard, friable, sticky and plastic; many fine and medium and few coarse roots; many, very fine and fine, tubular pores; many thin clay films lining pores and on ped faces; medium acid; gradual, wavy boundary.

B22t—21 to 27 inches, reddish-brown (5YR 4/4) heavy clay loam, dark reddish brown (5YR 3/4) when moist; moderate, coarse, subangular blocky structure parting to moderate, fine, subangular blocky; very hard, friable, sticky and plastic; few fine and coarse and common medium roots; common, very fine and fine, tubular pores; continuous thin clay films lining pores and on ped faces; medium acid; abrupt, irregular boundary.

R—27 to 32 inches, yellowish-brown (10YR 5/6) sandstone; soil material and clay films along cleavages.

The A horizon is brown, dark brown, or reddisb brown in hues of 5YR, 7.5YR, or 10YR. Moist values and chromas are 3 or less. The A horizon is sandy loam or loam. It has weak or moderate, fine or medium, granular or subangular blocky structure and is medium acid or slightly acid.

The B1 horizon has the same color and reaction ranges as the A horizon. It is heavy loam or light clay loam and has weak or moderate, subangular blocky structure. The B2t horizon is typically clay loam and contains less than 35 percent clay. It is brown or reddish brown in hues of 5YR or 7.5YR. Moist chromas are 4 or more. The B2t horizon has weak or moderate, subangular blocky structure. In some places a yellowish-brown B3 horizon is present.

The R layer is sandstone or shale.

LeE—Los Gatos loam, 15 to 30 percent slopes. This hilly soil is on uplands. Included with it in mapping are Dibble clay loam, Los Osos clay loam, and Millsholm loam. Each of these soils makes up about 5 percent of the mapping unit.

Runoff is medium, and the hazard of erosion is moderate where the soil is bare.

This soil is used for range. Capability unit IVe–1 (15) ; Loamy range site.

LeF—Los Gatos loam, 30 to 50 percent slopes. This steep soil is on uplands. It has the profile described as representative of the series.

Included with this soil in mapping are Dibble clay loam, Los Osos clay loam, and Millsholm loam. Each of these areas makes up about 4 percent of the mapping unit. Also included are areas of Vallecitos loam that make up 3 percent.

Runoff is medium to rapid, and the hazard of erosion is moderate to high where the soil is bare.

This soil is used for range, wildlife habitat, and watershed. Capability unit VIe–1 (15); Loamy range site, steep.

LeG—Los Gatos loam, 50 to 75 percent slopes. This very steep soil is on uplands. Included with it in mapping are Los Osos clay loam, Millsholm loam, and Gaviota sandy loam. Each of these soils makes up about 4 percent of the mapping unit. Also included are sandstone outcrops that make up about 3 percent.

Runoff is rapid, and the hazard of erosion is high where the soil is bare.

This soil is used for range, wildlife habitat, and watershed. Capability unit VIIe–1 (15); Loamy range site, very steep.

Los Osos Series

The Los Osos series consists of well-drained soils underlain by soft, fine-grained sandstone and shale. Slopes are 15 to 75 percent. Elevation ranges from 100 to 2,500 feet. The average annual air temperature is 59° F, and the frost-free season is 260 to 300 days. The average annual rainfall is 14 to 25 inches. These soils are moist from December to April and are dry from June to December in most years. Vegetation is annual grasses, forbs, and oak. Thick stands of oak, bayleaf, coyote bush, poison-oak, and sticky monkeyflower are in some areas.

In a representative profile the surface layer is gray, slightly acid clay loam about 10 inches thick. The subsoil is gray and grayish-brown, slightly acid light clay. It is underlain by soft, fine-grained sandstone at a depth of 32 inches.

Permeability is slow, and the available water capacity is 4 to 7 inches. Roots can penetrate to a depth of 24 to 40 inches.

Los Osos soils are used for range, wildlife habitat, watershed, and urban structures.

Representative profile of Los Osos clay loam, 15 to 30 percent slopes, south of Rheem Boulevard and east of Moraga Road in NE¼SW¼ sec. 7, T. 1 S., R. 2 W.

A1—0 to 10 inches, gray (10YR 5/1) clay loam, very dark gray (10YR 3/1) when moist; weak, fine, subangular blocky structure; very hard, friable, slightly sticky and slightly plastic; many very fine roots; common, very fine, interstitial and tubular pores; slightly acid; diffuse, wavy boundary.

B1t—10 to 20 inches, gray (10YR 5/1) light clay, very dark gray (10YR 4/1) when moist; weak, coarse, prismatic structure parting to moderate, fine, subangular blocky; extremely hard, firm, sticky and plastic; many very fine roots; common, very fine, tubular pores; few thin clay films on ped faces and lining pores; slightly acid; diffuse, wavy boundary.

B2t—20 to 32 inches, grayish-brown (10YR 5/2) light clay, very dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; extremely hard, firm, sticky and plastic; common very fine roots; common, very fine, tubular pores; continuous thin clay films on ped faces and lining pores; slightly acid; clear, wavy boundary.

R—32 to 38 inches, soft, fine-grained sandstone, slightly acid.

The A horizon is 8 to 12 inches thick. It is gray, dark gray, grayish brown, dark grayish brown, brown, or dark brown. It is typically clay loam but is loam in places. The A horizon has weak or moderate, granular or subangular blocky structure and is medium acid, slightly acid, or neutral.

The B2t horizon is gray, grayish brown, brown, or yellowish brown in hues of 2.5Y, 10YR, or 7.5YR. Moist values are 4 or more. The B2t horizon is heavy clay loam or clay. It is medium acid to neutral.

Depth to sandstone or shale is 24 to 40 inches.

LhE—Los Osos clay loam, 15 to 30 percent slopes. This hilly soil is on uplands. It has the profile described as representative of the series.

Included with this soil in mapping are Alo clay, which makes up about 5 percent of the mapping unit, Lodo clay loam and Millsholm loam, each of which makes up 3 percent, Los Gatos loam, which makes up 2 percent, and Diablo clay and Tierra loam, each of which makes up 1 percent. Also included are a few areas of rolling Los Osos soils.

Runoff is medium, and the hazard of erosion is moderate where the soil is bare.

This soil is used mainly for range, but a few areas are used for homesites. Capability unit IVe–3(15); Fine Loamy range site.

LhF—Los Osos clay loam, 30 to 50 percent slopes. This steep soil is on uplands. Included with it in mapping are areas of Alo clay that make up about 5 percent of the mapping unit, areas of Lodo clay loam that make up 3 percent, and areas of Millsholm loam that make up 2 percent. Areas of soil slips that are 2 to 5 feet deep make up 5 percent of the mapping unit. In some places soil slips cover 15 percent of the mapped area.

Runoff is medium to rapid, and the hazard of erosion is moderate to high where the soil is bare.

This soil is used for range, wildlife habitat, watershed, and some homesites. Capability unit VIe–1(15); Fine Loamy range site, steep.

LhG—Los Osos clay loam, 50 to 75 percent slopes. This very steep soil is on uplands. Included with in in mapping are Millsholm loam, which makes up about 4 percent of the mapping unit, and Lodo clay loam and Alo clay, each of which makes up 3 percent. Also included are areas of soil slips or landslides that make up 3 percent, and rock outcrops that make up as much as 2 percent.

Runoff is rapid, and the hazard of erosion is high.

This soil is used for range, wildlife habitat, and watershed. Capability unit VIIe–1(15); Fine Loamy range site, very steep.

Lk—Los Osos-Los Gatos complex. This complex consists of very steep soils that are intricately mixed and do not occur in a predictable pattern. It is 60 percent Los Osos clay loam and 35 percent Los Gatos loam. As much as 5 percent is rock outcrops. Slopes are 50 to 75 percent.

Where the soils are bare, runoff is rapid and the hazard of erosion is high. The vegetation is thick stands of oak, laurel, poison-oak, medrone, and bayleaf and some patches of coyote bush.

The soils in this complex are used for wildlife habitat, watershed, and range. Capability unit VIIe–1(15); Fine Loamy range site, very steep.

Los Robles Series

The Los Robles series consists of well-drained soils that formed in alluvium mainly from basic igneous rock. These soils are in the Clayton Valley. Slopes are 0 to 2 percent. Elevation ranges from 100 to 1,000 feet. The average annual air temperature is 59° F., and the frost-free season is 250 to 290 days. The average annual rainfall is 14 to 16 inches. These soils are moist between depths of 4 and 12 inches from November to June and are dry from June to November in most years. Vegetation is annual grasses, forbs, and scattered oaks.

In a representative profile the surface layer is dark-brown, neutral and mildly alkaline clay loam about 34 inches thick. The subsoil is dark-brown, moderately alkaline heavy clay loam about 21 inches thick. The substratum is brown, moderately alkaline clay loam that extends to a depth of more than 60 inches.

Permeability is moderately slow, and the available water capacity is 9 to 11 inches. Roots can penetrate to a depth of 60 inches.

Los Robles soils are used for homesites, and small areas are used for dryland walnuts.

Representative profile of Los Rohles clay loam, 50 feet south of Clayton Road and 1,600 feet west of Ygnacio Valley Road.

Ap—0 to 6 inches, dark-brown (7.5YR 3/2), clay loam, very dark brown (7.5YR 2/2) when moist; massive; hard, friable, sticky and plastic; many very fine roots; few, very fine, tubular pores and common, very fine and fine, interstitial pores; neutral; abrupt, smooth boundary.

A12—6 to 19 inches, dark-brown (7.5YR 3/2) clay loam, very dark brown (7.5YR 2/2) when moist; massive; hard, friable, sticky and plastic; common very fine roots; common, very fine and fine, interstitial pores and common, very fine, tubular pores; neutral; gradual, wavy boundary.

A13—19 to 34 inches, dark-brown (7.5YR 3/2) clay loam, very dark brown (7.5YR 2/2) when moist; massive; bard, friable, sticky and plastic; common, very fine roots and few, coarse roots; common, very fine and fine, interstitial pores; mildly alkaline; gradual, wavy boundary.

B21—34 to 44 inches, dark-brown (7.5YR 4/2) heavy clay loam, dark brown (7.5YR 3/2) when moist; weak, medium, subangular, blocky structure; hard, friable, sticky and plastic; common very fine and few coarse roots; few, very fine, tubular pores; moderately alkaline; clear, wavy boundary.

B22—44 to 55 inches, brown (7.5YR 5/3) heavy clay loam, dark reddish brown (5YR 3/3) when moist; weak, medium, subangular blocky structure; hard, friable, sticky and plastic; few very fine roots; few, very fine, tubular pores; moderately alkaline; diffuse, wavy boundary.

C—55 to 62 inches, brown (7.5YR 5/4) clay loam, brown (7.5YR 4/4) when moist; massive; hard, friable, sticky and plastic; few very fine roots; few, very fine, tubular pores; moderately alkaline.

The A horizon is 20 to 34 inches thick. It ranges from dark brown and brown to very dark brown in hues of 7.5YR or 10YR. It is loam or clay loam and contains as much as 10 percent gravel, by volume. It is slightly acid to mildly alkaline.

The B horizon is 20 to 40 inches thick. It is brown, dark brown, or dark grayish brown. It is mildly alkaline or moderatly alkaline.

The C horizon is clay loam or clay and contains as much as 10 percent gravel, by volume.

Lm—Los Robles clay loam. This is the only Los Robles soil mapped in the county. Included with it in mapping are areas of Rincon clay loam that make up 5 percent of the mapping unit and areas of Perkins gravelly clay loam that make up 3 percent. Also included are about 120 acres where slopes are 2 to 5 percent.

Runoff is slow, and the hazard of erosion is slight where the soil is tilled and exposed.

This soil is used mainly for homesites. Small areas are used for dryland walnuts. Capability unit I(17).

Marcuse Series

The Marcuse series consists of very poorly drained and poorly drained soils that formed in alluvium from sedimentary rock. These soils are along lower edges of valley fill and on rims of basins. Slopes are 0 to 2 percent. Elevation ranges from 0 to 5 feet. The average annual air temperature is 60° F., and the frost-free season is 250 to 275 days. The average annual rainfall is 10 to 14 inches. These soils are saturated from mid-December to early in March unless they are artifically drained. Vegetation is saltbush, pickleweed, and meadow barley.

In a representative profile the surface layer is faintly mottled grayish-brown, dark grayish-brown, and light olive-brown, moderately alkaline clay about 9 inches thick. The subsoil is mottled dark-gray, dark grayish-brown, brown, and olive-brown, moderately alkaline clay about 28 inches thick. The substratum, to a depth of 60 inches, is mottled dark grayish-brown, brown, and grayish-brown, moderately alkaline clay.

Permeability is slow, and the available water capacity is 5 to 7 inches. Reclamation has lowered the water table. Roots can penetrate to a depth of 40 to 50 inches.

Marcuse soils are used mainly for irrigated and dryland pasture. A few areas are used for irrigated row crops.

Representative profile of Marcuse clay, northeast of the intersection of State Highway 4 and Bixler Road, about 6 miles southeast of Brentwood in SW¼ SW¼NW¼ sec. 25, T. 1 N., R. 3 E.

A11—0 to 7 inches, faintly mottled grayish-brown (2.5Y 5/2) and dark grayish-brown (2.5Y 4/2) clay, dark grayish brown (2.5Y 4/2) and very dark grayish brown (2.5Y 3/2) when moist; massive, surface inch is moderate fine granular structure; extremely hard, firm, sticky and very plastic; many very fine roots; few, very fine, tubular pores; numerous gypsum seams; moderately alkaline; abrupt, smooth boundary.

A12—7 to 9 inches, mottled grayish-brown (2.5Y 5/2) and light olive-brown (2.5Y 5/4) silty clay, very dark grayish brown (2.5Y 3/2) and olive brown (2.5Y 4/4) when moist; weak, medium, platy structure; hard, friable, sticky and slightly plastic; many very fine roots; common, very fine, tubular pores; numerous gypsum seams; moderately alkaline; abrupt, smooth boundary.

B21—9 to 14 inches, mottled dark-gray (10YR 4/1) and dark grayish-brown (2.5Y 4/2) clay, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure; very hard, firm, sticky and very plastic; few very fine and common fine roots; few, very fine, tubular pores; very few thin clay films on ped faces and lining pores; moderately alkaline; gypsum in seams; gradual, smooth boundary.

B22ca—14 to 24 inches, mottled brown (10 YR 5/3) and dark grayish-brown (2.5Y 4/2) clay, very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3) when moist; weak, medium, angular blocky structure; very hard, friable, sticky and very plastic; few very fine and common fine roots; few, very fine, tubular pores; few thin clay films on ped faces and lining pores; violently effervescent; lime is disseminated and in seams and soft bodies; moderately alkaline; gradual, smooth boundary.

B3—24 to 37 inches, mottled dark grayish-brown (10YR 4/2) and olive-brown (2.5Y 4/4) clay, very dark grayish brown (10YR 3/2), dark grayish brown (2.5Y 4/2), and olive brown (2.5Y 4/4) when moist; weak, medium, angular blocky structure; very hard, firm, sticky and very plastic; few very fine and fine roots; common, very fine, tubular pores; few thin clay films on ped faces and pores; strongly effervescent; lime is disseminated and in small soft bodies; moderately alkaline; clear, smooth boundary.

C—37 to 60 inches, mottled dark grayish-brown (10YR 4/2), brown (10YR 4/3), and grayish-brown (2.5Y 5/2) clay, dark brown (10YR 3/3) with very dark grayish-brown (2.5Y 3/2) and olive-gray (5Y 4/2) mottles when moist; moderate, fine, angular blocky structure; very hard, firm, sticky and very plastic; very few very fine roots; common, very fine, tubular pores; few thin clay films on ped faces and in pores; slightly effervescent; lime is disseminated and in small bodies; moderately alkaline.

The A horizon is mottled grayish brown, olive brown, dark grayish brown, or brown in hues of 2.5Y and 10YR. It is heavy silty clay loam, silty clay, or clay. The A11 horizon has weak, very coarse, prismatic structure or is massive. Where they are present, very coarse prisms are larger than 12 inches in diameter.

The B horizon is dark gray, dark grayish brown, grayish brown, or brown in hues of 10YR or 2.5Y. Mottles are mixed randomly and generally differ from the matrix hy 2 or less value, one chroma unit, or both. The B2 horizon is silty clay or clay and contains less than 8 percent more clay than the A horizon. It is moderately alkaline or strongly alkaline.

The C horizon is silty clay loam, clay loam, silty clay, or clay.

Cracks ½ inch to 1 inch wide extend to a depth of 20 to 30 inches at some period in most years. Depth to carbonates ranges from 12 to 20 inches. Numerous gypsum seams are between depths of 1 and 14 inches. The percentage of exchangeable sodium is more than 15 and increases with depth as far as the C horizon.

Ma—Marcuse sand. This nearly level soil has a profile similar to the one described as representative of

the series, but the surface layer is sand or loamy sand 4 to 24 inches thick. Included with it in mapping are Marcuse clay and Capay clay, each of which makes up about 5 percent of the mapping unit, and Delhi sand, which makes up 4 percent.

This soil is poorly drained. It is subject to ponding, or water runs off very slowly. There is no hazard of erosion.

This soil is used for irrigated row crops and pasture. Capability unit IVw–6(17).

Mb—Marcuse clay. This soil has slopes of less than 2 percent. It has the profile described as representative of the series.

Included with this soil in mapping are areas of Marcuse clay, strongly alkali, that make up about 10 percent of the mapping unit and areas of Sacramento clay, alkali, that make up 5 percent.

This soil is poorly drained. It is subject to ponding, or water runs off very slowly. There is no hazard of erosion. About 5 to 35 percent of the mapping unit is unsuited to most crops because it is affected by saline-alkali salts.

This soil is used mainly for irrigated pasture. Some areas are used for irrigated row crops. Capability unit IVw–6(17).

Mc—Marcuse clay, strongly alkali. This soil is nearly level. It has a profile similar to the one described as representative of the series, but it has a high alkali content.

Included with this soil in mapping are areas of Marcuse clay that make up about 10 percent of the mapping unit and areas of Sacramento clay, alkali, that make up 5 percent.

More than 35 percent of the mapping unit is unsuited to most crops because it is affected by excessive saliue-alkali salts. This soil is very poorly drained.

This soil is used for irrigated and dryland pasture. Capability unit VIw–1(17).

Merritt Series

The Merritt series consists of poorly drained soils that formed in alluvium of mixed origin. These soils are in old stream channels and on terraces on the delta. Slopes are 0 to 2 percent. Elevation is less than 20 feet. The average annual air temperature is about 60° F., aud the frost-free season is 260 to 300 days. The average annual rainfall is 12 to 14 inches. Vegetation is annual grasses and forbs.

In a representative profile the surface layer is dark-gray, slightly acid loam about 16 inches thick. The substratum is gray, mottled, medium acid silt loam to a depth of 40 inches and grayish-brown, mottled, slightly acid silt loam to a depth of 52 inches. Below this is very dark gray, neutral clay loam that extends to a depth of more than 60 inches.

Permeability is moderate, and the available water capacity is 6 to 9 inches. Reclamation has lowered the water table. Roots can penetrate to a depth of 40 to 60 inches or more.

Merritt soils are used mainly for irrigated corn, sorghum, tomatoes, and pasture. A few areas are used for irrigated sugar beets.

Representative profile of Merritt loam in NE¼NE¼NE¼ sec. 13, T. 1 S., R. 3 E. (projected).

Ap—0 to 16 inches, dark-gray (10YR 4/1) loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and sligbtly plastic; common fine roots; common, very fine, tubular pores; few mica flakes; slightly acid; clear, smooth boundary.

C1—16 to 40 inches, gray (10YR 5/1) silt loam, dark gray (10YR 4/1) when moist; common, medium, prominent, red (2.5YR 5/6) mottles, red (2.5YR 4/6) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; no roots; few, very fine, tubular pores; about 15 percent mica flakes; medium acid; gradual, smooth boundary.

C2—40 to 52 inches, grayish-brown (2.5Y 5/2) silt loam, dark grayish brown (2.5Y 4/2) when moist; common, medium, faint, dark grayish-brown (2.5Y 4/2) mottles, very dark grayish brown (2.5Y 3/2) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few, very fine, tubular pores; about 10 percent mica flakes; slightly acid; abrupt, smooth boundary.

A1b—52 to 60 inches, very dark gray (10YR 3/1) clay loam, black (10YR 2/1) when moist; massive; hard, firm, sticky and plastic; neutral.

The A horizon is 12 to 20 inches thick. It is very dark gray or very dark grayish brown (10YR 3/1, 3/2, or 2.5Y 3/2) and is silt loam, silty clay loam, or loam. It is neutral or slightly acid. The A horizon contains as much as 5 percent small mica flakes in places.

The C horizon is brown (10YR 5/3), dark grayish brown (10YR 4/2 or 2.5Y 4/2), gray (10YR 5/1), or grayish brown (10YR 5/2 or 2.5Y 4/2). It is silt loam, silty clay loam, or clay loam. Mottles are dark grayish brown, red, reddish brown, or reddish gray. Clay content between depths of 10 and 40 inches ranges from 18 to 30 percent. Mica content of the C horizon is as much as 20 percent in some places. The C horizon ranges from neutral to medium acid. In places the C horizon is underlain by a black or very dark gray A1b horizon at a depth of more than 50 inches.

These soils are noncalcareous throughout and contain relatively larger amounts of micaceous material than is defined in the range for the Merritt series. These differences do not greatly affect their use and behavior.

Md—Merritt loam. This nearly level soil is in old river channels and on terraces. It is the only Merritt soil mapped in the county.

Included with this soil in mapping are Ryde silt loam and Egbert mucky clay loam, each of which makes up about 5 percent of the mapping unit, and Kingile muck, which makes up less than 1 percent. Also included are small areas of a soil that has a dark-colored surface layer more than 20 inches thick. These areas make up less than 1 percent.

Runoff is very slow, and there is no hazard of erosion where the soil is tilled and exposed.

This soil is used for irrigated corn, milo, tomatoes, and pasture. Capability unit IIIw–2(16).

Millsholm Series

The Millsholm series consists of well-drained soils that formed from interbedded shale and fine-grained sandstone. These soils are on uplands. Slopes are 15 to 75 percent. Elevation ranges from 300 to 2,000 feet. The average annual air temperature is about 59° F.,

and the frost-free season is 250 to 300 days. The average annual rainfall is 14 to 24 inches. These soils are generally moist throughout from mid-December to May and are dry from June to November. Vegetation is annual grasses, forbs, and scattered oaks. Thick stands of coyote bush are in some areas.

In a representative profile the surface layer is grayish-brown, medium acid loam about 4 inches thick. The subsoil is also grayish-brown, medium acid loam. It is underlain at a depth of about 12 inches by sandstone.

Permeability is moderate, and the available water capacity is 2 to 4 inches. Roots can penetrate to a depth of 10 to 20 inches.

Millsholm soils are used for range, wildlife habitat, and watershed.

Representative profile of Millsholm loam, 30 to 50 percent slopes, on Oursan Ridge in NW¼SW¼NW¼ sec. 6, T. 1 N., R. 3 W.

A1—0 to 4 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; massive; hard, friable, sticky and slightly plastic; many very fine roots; few, very fine, tubular pores; medium acid; clear, smooth boundary.

B2—4 to 12 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; weak, fine, subangular blocky structure; hard, friable, sticky and slightly plastic; many very fine roots; common, very fine, tubular pores; medium acid; abrupt, smooth boundary.

R—12 to 20 inches, fractured, fine-grained, light yellowish-brown (10YR 6/4) and strong-brown (7.5YR 5/6) sandstone; very dark brown (10YR 2/2) stains along fracture planes.

The A horizon is grayish brown, brown, or olive brown in hues of 10YR and 2.5Y. Moist values are 3 or 4. The A horizon is loam, silt loam, or light clay loam. Where the moist value is 3, the A horizon is massive. Where the moist value is 4, it is massive or has weak, granular or weak, subangular blocky structure. The A horizon ranges from strongly acid to slightly acid.

The B2 horizon has the same color, texture, and reaction as the A horizon, but it has weak, fine or medium, subangular blocky structure.

Depth to bedrock ranges from 10 to 20 inches. The parent rock is shale, sandstone, or interbedded sandstone and shale. Hardness of the parent rock is 3 to 4 on the Mohs scale.

MeE—Millsholm loam, 15 to 30 percent slopes. This moderately steep soil is on uplands. Included with it in mapping are areas of soils that are similar to Millsholm loam but that have softer bedrock. These areas make up about 8 percent of the mapping unit. Also included are areas of Los Osos clay loam that make up 4 percent and areas of Los Gatos loam, generally on toe slopes and in concave areas, that make up 3 percent. A few areas of Millsholm loam that has slopes of 5 to 9 percent are also included.

Runoff is medium, and the hazard of erosion is moderate where the soil is bare.

This soil is used mainly for range, wildlife habitat, and watershed. Capability unit VIe–1 (15); Shallow Fine Loamy range site.

MeF—Millsholm loam, 30 to 50 percent slopes. This steep soil is on uplands. It has the profile described as representative of the series.

Included with this soil in mapping are areas of soils that are similar to Millsholm loam but that have softer bedrock. These areas make up about 7 percent of the mapping unit. Also included are areas of Los Osos clay loam that make up 5 percent and areas of Los Gatos loam, generally on toe slopes and in concave areas, that make up 3 percent.

Runoff is rapid, and the hazard of erosion is high where the soil is bare.

This soil is used mainly for range, wildlife habitat, and watershed. Capability unit VIIe–1 (15); Shallow Fine Loamy range site, steep.

MeG—Millsholm loam, 50 to 75 percent slopes. This very steep soil is on uplands. Included with it in mapping are areas of soils that are similar to Millsholm loam but that have softer bedrock. These areas make up about 6 percent of the mapping unit. Also included are areas of Los Osos clay loam that make up 3 percent and areas of Los Gatos loam, generally on toe slopes and in concave areas, that make up 3 percent. Areas of Felton loam near woodlands in the far western part of the county make up 2 percent. A few areas of Gaviota sandy loam that is underlain by coarse-grained sandstone are also included.

Runoff is rapid, and the hazard of erosion is very high where the soil is bare.

This soil is used mainly for range, wildlife habitat, and watershed. Capability unit VIIe–1 (15); Shallow Fine Loamy range site, very steep.

Omni Series

The Omni series consists of poorly drained soils that formed in alluvium from sedimentary rock. These soils are on the lower flood plains of Walnut Creek, Mount Diablo Creek, Grayson Creek, and other small tributaries. Slopes are 0 to 2 percent. Elevation ranges from 10 to 100 feet. The average annual air temperature is 59° F., and the frost-free season is 260 to 300 days. The average annual rainfall is about 14 to 16 inches. Vegetation is annual grasses and forbs and pickleweed in some places.

In a representative profile the upper part of the surface layer is grayish-brown, moderately alkaline clay loam about 8 inches thick, and the lower part is gray, moderately alkaline clay about 11 inches thick. The substratum, to a depth of 58 inches, is gray, grayish-brown, and dark grayish-brown, stratified, moderately alkaline sandy clay, clay, sandy clay loam, and clay loam. Below this the substratum is gray, moderately alkaline, loamy sand that extends to a depth of more than 60 inches.

Permeability is slow, and the available water capacity is 4 to 8 inches. Roots can penetrate to a depth of 30 to 50 inches.

Omni soils are used for irrigated sorghum, sugar beets, tomatoes, and pasture and dryland barley and pasture. Some areas are used for sanitary landfill.

Representative profile of Omni clay loam, west of Avon in the center of NE¼ sec. 22, T. 2 N., R. 1 W.

Ap—0 to 8 inches, grayish-brown (2.5Y 5/2) clay loam, very dark grayish brown (2.5Y 3/2) when moist; moderate, fine and medium, subangular blocky structure; very hard, firm, slightly sticky and plastic; many very fine roots; common, very fine, tubular pores; moderately alkaline; slightly cal-

careous; disseminated lime; abrupt, smooth boundary.

A12—8 to 19 inches, gray (10YR 5/1) clay, very dark gray (10YR 3/1) when moist; common, medium, distinct, grayish-brown (10YR 5/2) mottles, dark grayish brown (10YR 4/2) when moist; few, very dark gray, organic stains on ped faces; weak, coarse, prismatic structure; extremely hard, very firm, sticky and very plastic; many very fine roots; many, very fine, tubular pores; moderately alkaline; slightly calcareous; disseminated lime and angular soft masses of lime; gradual, wavy boundary.

C1ca—19 to 34 inches, mottled grayish-brown (10YR 5/2) and gray (10YR 5/1) clay with thin layers (less than 2 inches thick) of sandy clay, mottled very dark grayish brown (2.5Y 3/2), brownish yellow (10YR 6/6), and red (2.5YR 3/2) when moist; weak, medium, subangular blocky structure; very hard, very firm, sticky and very plastic; many very fine roots; common, very fine, tubular pores; moderately alkaline; strongly calcareous; disseminated lime and soft masses of lime; clear, wavy boundary.

C2—34 to 38 inches, mottled grayish-brown (2.5Y 5/2), dark grayish-brown (2.5Y 4/2), and yellowish-red (5Y 5/6) clay, mottled olive gray (5Y 4/2), very dark gray (10YR 3/1), and reddish brown (5YR 5/4) when moist; many black (N 2/0) organic stains on ped faces; weak, coarse, subangular blocky structure; very hard, very firm, sticky and very plastic; very few very fine roots; very few, very fine, tubular pores; moderately alkaline; slightly calcareous; disseminated lime; clear, wavy boundary.

IIC3—38 to 50 inches, gray (10YR 5/1) sandy clay loam, very dark grayish brown (2.5Y 3/2) when moist; common, fine, distinct, brownish-yellow (10YR 6/6) mottles; weak, thin, platy structure; hard, friable, sticky and plastic; very few very fine roots; very few, very fine, tubular pores; moderately alkaline; slightly calcareous; disseminated lime; gradual, wavy boundary.

IIIC4—50 to 58 inches, mottled grayish-brown (2.5Y 5/2) and dark grayish-brown (2.5Y 4/2) clay loam, mottled olive gray (5Y 4/2) and very dark gray (5Y 3/2) when moist; weak, thin, platy structure; hard, friable, sticky and plastic; moderately alkaline; abrupt, smooth boundary.

IVC5—58 to 72 inches, gray (10YR 5/1) loamy sand with fine seams (less than 2 inches thick) of silt and clay, dark greenish gray (5GY 4/1) when moist; massive; hard, friable, slightly sticky and slightly plastic; moderately alkaline; strongly calcareous; disseminated lime.

The A horizon is grayish brown, dark grayish brown, very dark grayish brown, gray, dark gray, or very dark gray in hues of 10YR and 2.5Y. It has moist values of 2 or 3. It is clay loam, silty clay loam, silty clay, or clay.

The upper part of the C horizon is mottled and clayey, although it has thin strata of coarser material in some places. Lime is disseminated or in soft masses. The lower part of the C horizon is mottled and stratified. It contains secondary lime in places. In some places the C horizon contains gypsum in some parts.

The soil is generally calcareous throughout to a depth of 50 inches.

Oa—Omni clay loam. This soil has slopes of 0 to 2 percent. It has the profile described as representative of the series.

Included with this soil in mapping are Laugenour loam and Sycamore silty clay loam, each of which makes up about 5 percent of the mapping unit, and Marcuse clay, which makes up 2 percent.

This soil is subject to occasional ponding, or surface water runs off very slowly. There is no hazard of erosion where the soil is tilled and exposed. The water table has been lowered to a depth of 40 to 50 inches by levees and channel improvement. Roots can penetrate to a depth of 40 to 50 inches.

This soil is used for irrigated sorghum, sugar beets, tomatoes, and pasture and for dryland pasture and some barley. Capability unit IIw–2(17).

Ob—Omni silty clay. This soil has slopes of less than 2 percent. It is on the lower edges of the flood plains of Grayson Creek and Walnut Creek. It has a profile similar to the one described as representative of the series, but it has a surface layer of silty clay and is noncalcareous between depths of 10 and 20 inches.

Included with this soil in mapping are Marcuse clay and Reyes silty clay, each of which makes up about 5 percent of the mapping unit.

This soil is subject to occasional ponding, or surface water runs off very slowly. There is no hazard of erosion where the soil is tilled and exposed. Reclamation has lowered the water table to a depth of about 30 to 48 inches. Roots can penetrate to a depth of 30 to 48 inches. Moderate salinity limits crops to salt-tolerant plants.

This soil is used for dryland pasture and sanitary landfill. Capability unit IVw–6(17).

Perkins Series

The Perkins series consists of well-drained soils underlain by weakly consolidated, gravelly old alluvium. These soils are on old terraces. Slopes are 2 to 15 percent. Elevation ranges from 300 to 800 feet. The average annual air temperature is 59° F., and the frost-free season is 260 to 300 days. The average annual rainfall is 14 to 18 inches. These soils are generally moist from December to April and are dry from May to November in most years. Vegetation is annual grasses, forbs, and scattered oaks.

In a representative profile the surface layer is reddish-brown and reddish-gray, slightly acid gravelly heavy loam about 19 inches thick. The subsoil is weak-red, slightly acid and neutral gravelly clay loam about 21 inches thick. The substratum is reddish-brown, mildly alkaline, weakly consolidated gravelly clay loam that extends to a depth of more than 60 inches.

Permeability is slow in the weakly consolidated substratum. The available water capacity is 5 to 8 inches. Roots can penetrate to a depth of 36 to 50 inches.

Perkins soils are used for range and homesites.

Representative profile of Perkins gravelly loam, 2 to 9 percent slopes, about 1 mile south of Clayton in SW¼NE¼NE¼SW¼ sec. 14, T. 1 N., R. 1 W.

Ap—0 to 6 inches, reddish-brown (5YR 5/3) gravelly heavy loam, dark reddish brown (5YR 3/3) when moist; massive; hard, friable, sticky and slightly plastic; many very fine and few fine roots; few, very fine, tubular and interstitial pores; slightly acid; clear, smooth boundary.

A12—6 to 19 inches, reddish-gray (5YR 5/2) gravelly heavy loam, dusky red (2.5YR 3/2) when moist; massive; hard, friable, sticky and slightly plastic; many very fine and few fine roots; common, fine and very fine, tubular pores; slightly acid; gradual, wavy boundary.

B21t—19 to 32 inches, weak-red (2.5YR 5/2) gravelly clay loam, dusky red (2.5YR 3/2) when moist; weak, fine, subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; common, very fine, tubular pores; few thin clay films in pores; slightly acid; gradual, wavy boundary.

B22t—32 to 40 inches, weak-red (2.5YR 5/2) gravelly clay loam, dusky red (2.5YR 3/2) when moist; weak, fine, angular blocky structure; hard, firm, sticky and plastic; common very fine roots; common, very fine, tubular pores; continuous thin clay films in pores and on ped faces; neutral; clear, wavy boundary.

C—40 to 60 inches, reddish-brown (2.5YR 4/4) gravelly clay loam, dark reddish brown (2.5YR 3/4) when moist; massive; weakly consolidated; extremely hard, firm, sticky and plastic; no roots; few very fine pores; many thin clay films in pores; mildly alkaline.

The A horizon is 17 to 23 inches thick and is reddish brown, reddish gray, or brown. It is medium acid or slightly acid.

The B2t horizon is 19 to 27 inches thick and is weak red, reddish brown, or yellowish red in hues of 5YR and 2.5YR. It is slightly acid to mildly alkaline.

Gravel content throughout the solum is 15 to 30 percent.

PaC—Perkins gravelly loam, 2 to 9 percent slopes. This gently sloping and moderately sloping soil is on old terraces. It has the profile described as representative of the series.

Included with this soil in mapping are Kimball gravelly clay loam and Los Robles clay loam, each of which makes up about 5 percent of the mapping unit.

Runoff is slow to medium, and the hazard of erosion is slight to moderate where the soil is tilled and exposed.

This soil is used for range and homesites. Capability unit IIIe–3 (15) ; Claypan range site.

PaD—Perkins gravelly loam, 9 to 15 percent slopes. This strongly sloping soil is on old terraces. Included with it in mapping are areas of Kimball gravelly clay loam that make up about 5 percent of the mapping unit. Also included are areas of Perkins soils, on banks of terraces, that have slopes of 15 to 50 percent.

Runoff is medium, and the hazard of erosion is moderate where the soil is bare.

This soil is used for range and homesites. Capability unit IVe–3 (15) ; Claypan range site.

Pescadero Series

The Pescadero series consists of poorly drained soils that formed in alluvium from sedimentary rock. These soils are in small inland valleys and on rims of basins. Slopes are 0 to 2 percent. Elevation ranges from 10 to 100 feet. The average annual air temperature is 59° F., and the frost-free season is 260 to 280 days. The average annual rainfall is 14 to 19 inches. These soils are moist from December to April and are dry to a depth of 30 inches from June to November in most years. Vegetation is annual grasses, saltgrass, and some saltbush.

In a representative profile the surface layer is mixed light-gray, gray, and very dark gray, slightly acid light clay loam about 5 inches thick. The subsoil is black, strongly alkaline clay in the upper 16 inches and mottled dark-gray, grayish-brown, gray, and light yellowish-brown, moderately alkaline clay in the lower 22 inches. The substratum is olive-gray and pale-olive, moderately alkaline and very strongly alkaline sandy clay loam that extends to a depth of more than 60 inches.

Permeability is slow, and the available water capacity is 5 to 9 inches. Roots can penetrate to a depth of 48 to 60 inches or more.

Pescadero soils are used for dryland pasture and barley and for homesites.

Representative profile of Pescadero clay loam, 1.3 miles north of the intersection of Highway 21 and the Alameda-Contra Costa County line and 4,600 feet east of highway 21.

A2p—0 to 5 inches, mixed light-gray (10YR 6/1), gray (10YR 5/1), and very dark gray (10YR 3/1) light clay loam, mixed dark gray (10YR 4/1) and very dark grayish brown (10YR 3/2) when moist; moderate, coarse, prismatic structure; hard, friable, slightly sticky and slightly plastic; common very fine and fine and few medium roots; common, fine and very fine, tubular pores; slightly acid; clear, wavy boundary.

B21t—5 to 21 inches, black (N 2/0) clay, black (N 2/0) when moist; moderate, coarse, columnar structure parting to strong, medium, angular blocky; extremely hard, firm, sticky and plastic; common very fine roots; few, very fine, tubular pores; light-gray (2.5Y 7/2) coatings on ped faces; few thin clay films lining pores and on ped faces; strongly alkaline; strongly calcareous; gradual, wavy boundary.

B22t—21 to 28 inches, mottled dark-gray (N 4/0) and grayish-brown (2.5Y 5/2) clay, mottled black (N 2/0) and very dark grayish brown (2.5Y 3/2) when moist; moderate, coarse, prismatic structure parting to moderate, medium, angular blocky; extremely hard, firm, sticky and plastic; few very fine roots; few, very fine, tubular pores; common thin clay films lining pores and on ped faces; moderately alkaline; strongly calcareous; lime in soft masses; clear, wavy boundary.

B3t—28 to 43 inches, mottled grayish-brown (2.5Y 5/2), gray (N 5/0), and light yellowish-brown (2.5Y 6/4) clay, mottled dark grayish-brown (2.5Y 4/2), dark gray (N 4/0), and olive brown (2.5Y 4/4) when moist; weak, coarse, prismatic structure parting to weak, medium, angular blocky; extremely hard, firm, sticky and plastic; no roots; few, very fine, tubular pores; few thin clay films lining pores and on ped faces; moderately alkaline; strongly calcareous; lime in soft masses; abrupt, smooth boundary.

C1ca—43 to 47 inches, olive-gray (5Y 5/2) sandy clay loam, olive gray (5Y 5/2) when moist; weak, medium, angular blocky structure; extremely hard, firm, slightly sticky and plastic; few, very fine, tubular pores; few thin clay films lining pores and on ped faces; moderately alkaline; white (5Y 8/2) lime concretions; abrupt, smooth boundary.

C2—47 to 66 inches, pale-olive (5Y 6/3) sandy clay loam, olive (5Y 5/3) when moist; massive; extremely hard, firm, slightly sticky and slightly plastic; few, very fine, tubular pores; common iron and manganese concretions; very strongly alkaline; slightly calcareous.

The A horizon is light gray, gray, light brownish gray, very dark gray, or grayish brown, and moist values of 4 or more are dominant. The A1 horizon is present on the crests of microknolls and is absent in the troughs. It is clay loam or light clay and is 4 to 8 inches thick. The A2 horizon is loam, clay loam, or silty clay loam. It is slightly acid to strongly alkaline.

The Bt horizon has more than 15 percent sodium satura-

tion to a depth of 40 inches or more. The B2t horizon is black, very dark gray, or grayish-brown clay or silty clay. It has columnar or angular blocky structure in the upper part and columnar, prismatic, or angular blocky structure in the lower part. It is moderately alkaline or strongly alkaline.

The C horizon is sandy clay loam, clay loam, silty clay loam, or silty clay. It generally contains segregated lime in the upper part.

Pb—Pescadero clay loam. This nearly level soil has hummocky microrelief. It has the profile described as representative of the series.

Included with this soil in mapping are areas of Clear Lake clay that make up about 10 percent of the mapping unit.

This soil is subject to some ponding, and surface water runs off very slowly. There is no hazard of erosion where the soil is tilled and exposed. The water table has been lowered to a depth of more than 60 inches by stream cutting and reclamation. Roots of salt-tolerant plants can penetrate to a depth of 60 inches. The available water capacity is 7 to 9 inches. About 10 to 20 percent of the area is affected by alkali and is unsuited to most crops.

This soil is used mainly for dryland pasture and barley and for homesites. Capability unit IVw–6(17).

Pc—Pescadero clay loam, strongly alkali. This nearly level soil has hummocky microrelief. It has a profile similar to the one described as representative of the series, but it has a high alkali content.

Included with this soil in mapping are areas of Clear Lake clay that make up about 5 percent of the mapping unit and areas of Omni clay that make up 3 percent.

This soil is subject to some ponding and surface water runs off very slowly. There is no hazard of erosion where the soil is bare. The water table has been lowered to a depth of 4 to 5 feet by stream cutting. Roots of salt-tolerant plants can penetrate to a depth of 48 to 60 inches. The available water capacity is 5 to 7 inches. About 20 to 30 percent of the area is alkali soil that is unsuited to most crops.

This soil is used for dryland pasture. Capability unit VIw–1(17).

Piper Series

The Piper series consists of poorly drained soils formed on low eolian mounds and ridges that have become more prominent as the surrounding organic soils subsided. These soils are on the delta. Slopes are 0 to 5 percent. Elevation ranges from 0 to 25 feet. The average annual temperature is 60° F., and the frost-free season is 250 to 300 days. The average annual rainfall is 12 to 16 inches. Where these soils are not drained, they are saturated within a depth of 20 to 40 inches throughout the year and are saturated within a depth of 20 inches for 4 to 12 months each year. Vegetation is annual grasses, chiefly ripgut brome and red brome.

In a representative profile (fig. 6) the surface layer is moderately alkaline fine sandy loam about 10 inches thick. It is very dark gray in the upper part and light gray in the lower part. The subsoil is mottled, light-gray, moderately alkaline, weakly cemented fine sandy loam about 28 inches thick. The substratum is mottled, pale-brown, moderately alkaline fine sand that extends to a depth of more than 60 inches.

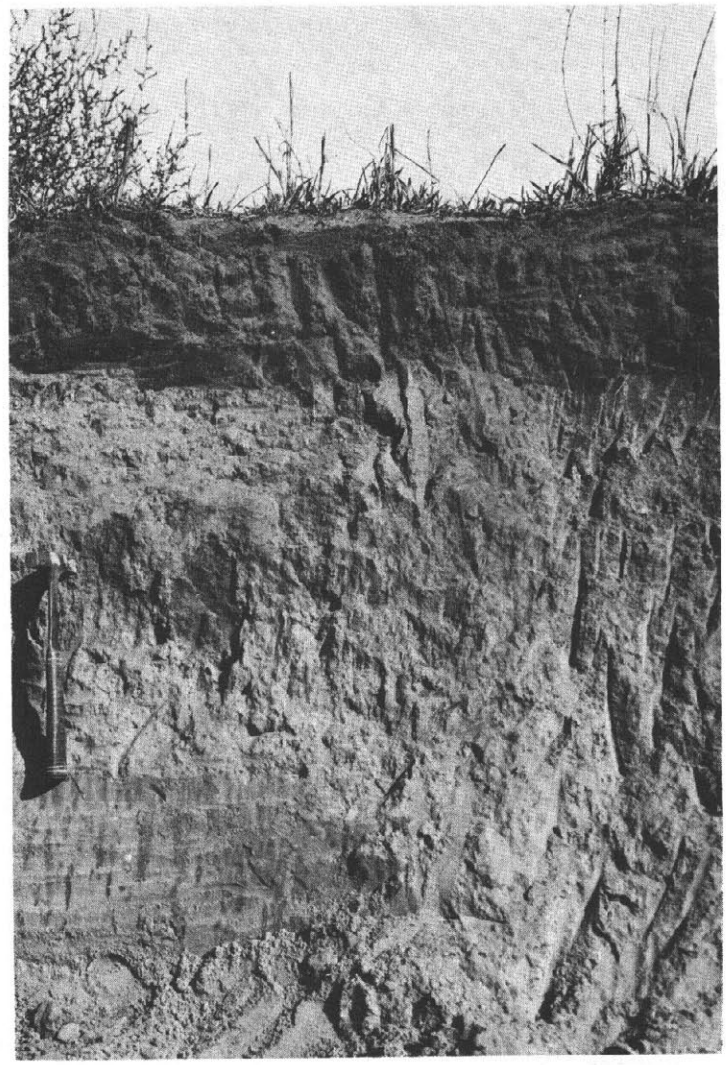

Figure 6.—**Typical profile of Piper fine sandy loam.**

Permeability is rapid to slow, and the available water capacity is 2.0 to 4.5 inches. Roots can penetrate to a depth of 20 to 50 inches.

Piper soils are used for irrigated alfalfa, apricots, some row crops, and pasture and for dryland pasture, some grain, and volunteer hay.

Representative profile of Piper fine sandy loam, on a gently rolling knoll on Bethel Island in SE¼SW¼ SW¼ sec. 23, T. 2 N., R. 3 E. (projected).

A11—0 to 4 inches, very dark gray (10YR 3/1) fine sandy loam, black (10YR 2/1) when moist; weak granular structure; soft, very friable, nonsticky and nonplastic; many very fine roots; many, very fine, interstitial pores; moderately alkaline; strongly effervescent; disseminated lime and few fine lime concretions; clear, wavy boundary.

A12—4 to 10 inches, light-gray (10YR 7/1) fine sandy loam, grayish brown (10YR 5/2) when moist; massive; soft, very friable, nonsticky and nonplas-

tic; many very fine roots; many, very fine and fine, tubular pores; rust-colored coatings on pores; common krotovinas; moderately alkaline; violently effervescent; disseminated lime; clear, smooth boundary.

B21ca—10 to 24 inches, light-gray (10YR 7/1) fine sandy loam, grayish brown (10YR 5/2) when moist; common, medium, prominent, reddish-yellow (7.5YR 6/6) and yellowish-brown (10YR 5/6) mottles; massive; hard, slightly brittle, weakly cemented in part of horizon, friable, nonsticky and nonplastic; few fine, medium, and coarse roots; few, fine and medium, tubular pores; moderately alkaline; violently effervescent; lime is disseminated and in soft bodies; diffuse, smooth boundary.

B22ca—24 to 38 inches, light-gray (10YR 7/2) fine sandy loam, light brownish gray (10YR 6/2) when moist; many, prominent, reddish-yellow (7.5YR 6/6) and yellowish-brown (10YR 5/6) mottles; massive; hard, slightly brittle, weakly cemented in part of horizon, friable, nonsticky and nonplastic; few coarse roots; few medium pores; moderately alkaline; violently effervescent; lime is disseminated and in soft bodies; clear, smooth boundary.

C—38 to 60 inches, pale-brown (10YR 6/3) fine sand, yellowish brown (10YR 5/4) when moist; many, coarse, distinct, strong-brown (7.5YR 5/6) mottles; massive; slightly hard, friable, nonsticky and nonplastic; moderately alkaline; violently effervescent.

The upper part of the A horizon is dark gray to very dark gray and is as much as 8 inches thick. It contains about 2 to 50 percent organic matter. The lower part of the A horizon is grayish brown, light brownish gray, or light gray in hues of 10YR or 2.5Y.

The B2 horizon has segregated lime in few to many seams or soft, rounded bodies. Part of this horizon generally has weak cementation, mostly by calcium carbonate, but cementation by silica also seems to be present. The B2 horizon is sandy loam or fine sandy loam, and the lower part, in some places has thin strata of loamy sand or sand. Average clay content is about 9 to 14 percent. Hue is 10YR or 2.5Y. Most mottles have a chroma of 4, 6, or 8 and a hue of 10YR or 7.5YR.

The C horizon, or the soil below a depth of about 40 inches, has hues of 10YR or 2.5Y and a chroma of 2 to 4. it is sand, loamy sand, or sandy loam and in most places is somewhat stratified. It is more sandy than the B2ca horizon.

Sodium saturation is less than 15 percent throughout or is less than 15 percent to a depth of 30 inches or more.

Pd—Piper sand. This soil is in concave areas and has slopes of 0 to 2 percent. The soil material is sand to a depth of 60 inches. It is weakly cemented between depths of 26 and 60 inches.

Included with this soil in mapping are areas of Delhi sand that make up about 5 percent of the mapping unit.

Runoff is very slow, and the hazard of soil blowing is slight where the soil is tilled and exposed. The depth to which roots can penetrate is limited to 30 to 40 inches by the water table. Permeability is moderate, and the available water capacity is 3.5 to 4.5 inches. Slight to moderate salinity influences the selection of crops.

This soil is used for dryland pasture, and a few areas are used for apricots. Capability until IVw–4 (16).

Pe—Piper loamy sand. This soil has slopes of 0 to 2 percent. It is on the delta and is 5 to 10 feet below sea level. It has a profile similar to the one described as representative of the series, but it is calcareous loamy sand to a depth of 60 inches and is not cemented. Deep cuts and fills have been made in leveling the soil for irrigation.

Included with this soil in mapping are areas of Shima muck that make up about 4 percent of the mapping unit and areas of Piper fine sandy loam that make up 3 percent. Also included are areas of a soil that is underlain by muck at a depth of 20 to 30 inches. These areas make up 8 percent.

This soil is subject to frequent ponding, and surface water runs off very slowly. Soil blowing is a hazard where the soil is tilled and exposed. The water table has been lowered to a depth of 40 to 50 inches by open drains and pumps. Roots can penetrate to a depth of 40 to 50 inches. Permeability is rapid, and the available water capacity is 2.5 to 4.5 inches.

This soil is used for irrigated pasture, alfalfa, and some row crops. Some areas are flooded during winter specifically for wildlife. Capability unit IVw–4 (16).

Ph—Piper fine sandy loam. This soil generally has slopes of 2 to 5 percent, but a few areas are nearly level. It has the profile described as representative of the series.

Included with this soil in mapping are Shima muck and Piper loamy sand, each of which makes up about 5 percent of the mapping unit.

Runoff is slow to medium. Permeability is slow in about 80 percent of the area and moderate in 20 percent because of the degree of cementation. Roots can penetrate to a depth of 20 to 36 inches. The available water capacity is 2 to 4 inches. Soil blowing is a moderate hazard where the soil is tilled and exposed.

This soil is used mainly for dryland pasture, some small grain, and volunteer hay. Capability unit IVe–9 (16).

Positas Series

The Positas series consists of moderately well drained soils underlain by weakly consolidated terrace material. These soils are on old terraces. Slopes are 0 to 9 percent. Elevation ranges from 200 to 600 feet. The average annual air temperature is 59° F., and the frost-free season is 260 to 290 days. The average annual rainfall is 15 to 18 inches. These soils are moist between depths of 16 and 24 inches from mid-December to May and are dry from May to November in most years. Vegetation is annual grasses and forbs.

In a representative profile the surface layer is brown, medium acid and slightly acid loam about 14 inches thick. The subsurface layer is faintly mottled brown and light-gray, slightly acid light clay loam about 7 inches thick. The upper part of the subsoil is faintly mottled reddish-brown and reddish-gray, medium acid and slightly acid clay about 22 inches thick. The lower part of the subsoil is mottled, brown, grayish-brown, and yellowish-brown, neutral clay that extends to a depth of more than 60 inches.

Permeability is very slow, and the available water capacity is 3 to 5 inches. Some moisture is available to plant roots from water that perches above the clay subsoil. Roots can penetrate to a depth of 16 to 24 inches.

Positas soils are used for range and homesites.

Representative profile of Positas loam, 2 to 9 percent slopes, along Valley Vista Road in SW¼SE¼ SW¼ sec. 20, T. 1 N., R. 1 W. (projected).

A11—0 to 6 inches, brown (10YR 5/3) loam, dark brown (10YR 3/3) when moist; massive; hard, friable, nonsticky and slightly plastic; many very fine and fine roots; many, very fine and fine, tubular pores; medium acid; distinct, smooth boundary.

A12—6 to 14 inches, brown (10YR 5/3) loam, dark brown (10YR 3/3) when moist; common very fine and fine roots; common, very fine and fine, tubular pores; slightly acid; gradual, wavy boundary.

A2—14 to 21 inches, faintly mottled brown (10YR 5/3) and light-gray (10YR 7/2) light clay loam with dark-brown stains, brown (10YR 5/3 and 4/3) with dark-brown (10YR 3/3) stains when moist; massive; hard, friable, slightly sticky and slightly plastic; common very fine roots; many, very fine and few, fine, tubular pores; slightly acid; abrupt, wavy boundary.

B21t—21 to 34 inches, faintly mottled reddish-brown (5YR 5/3) and reddish-gray (5YR 5/2) clay, reddish brown (5YR 4/4) and dark reddish brown (5YR 3/3 and 3/2) when moist; weak, coarse, prismatic structure parting to strong, medium, angular blocky; extremely hard, firm, slightly sticky and very plastic; common, very fine, exped roots; few, very fine, tubular pores; many thick clay films in pores and on ped faces; medium acid; diffuse, smooth boundary.

B22t—34 to 43 inches, faintly mottled reddish-brown (5YR 5/4 and 5/3) and reddish-gray (5YR 5/2) light clay, reddish brown (5YR 4/4) and dark reddish brown (5YR 3/3 and 3/2) when moist; strong, coarse and medium, angular blocky structure; extremely hard, firm, sticky and slightly plastic; common, very fine, exped roots; few or very few tubular pores; many thick clay films in pores and on ped faces; slightly acid; clear, wavy boundary.

B3—43 to 60 inches, mottled brown, grayish-brown, and yellowish-brown (10YR 5/2, 4/3, 5/4, and 7.5YR 5/4) clay, dark brown, brown, and dark yellowish brown (10YR 4/2, 4/3, 4/4, and 7.5YR 4/4) when moist; strong, medium, angular blocky structure; extremely hard, firm, sticky and very plastic; few very fine roots; very few, very fine, tubular pores; many thick clay films in pores and on ped faces; neutral.

The A1 horizon is 11 to 19 inches thick. It is brown or grayish-brown fine sandy loam or loam and is medium acid or slightly acid. The A2 horizon is 2 to 8 inches thick and is medium acid or slightly acid.

The B2t horizon is 17 to 25 inches thick. It is reddish brown, reddish gray, or brown in hues of 5YR or 7.5YR. The B2t horizon is medium acid to mildly alkaline, becoming more alkaline with depth. The B3 horizon is neutral to moderately alkaline. In some places the B3 horizon is calcareous.

PkA—Positas loam, 0 to 2 percent slopes. This nearly level soil is on terraces. Included with it in mapping are areas of Tierra loam along small drainageways that make up about 5 percent of the mapping unit.

Runoff is slow, and the hazard of erosion is slight where the soil is tilled and exposed.

This soil is used for range and homesites. Capability unit IIIs–3 (17) ; Claypan range site.

PkC—Positas loam, 2 to 9 percent slopes. This gently sloping to moderately sloping soil is on old terrace remnants. It has the profile described as representative of the series.

Included with this soil in mapping are areas of Tierra loam that makes up about 10 percent of the mapping unit.

Runoff is slow, and the hazard of erosion is slight where the soil is bare.

This soil is used for homesites and dryland pasture. Capability unit IVe–3 (15) ; Claypan range site.

Quarry

Qa—Quarry consists of areas that are being quarried extensively for rock, limestone, and soft sandstone. Also included are some areas that were mined in the past. Capability unit VIIIe–1 (15).

Reyes Series

The Reyes series consists of very poorly drained soils in saltwater marshes affected by tides. Slopes are less than 1 percent. Elevation is at or near sea level. The average annual soil temperature is 59° F., and the frost-free season is 260 to 300 days. The average annual precipitation is 14 to 22 inches. Vegetation is pickleweed, saltgrass, and some sedges.

In a representative profile the surface layer is very dark grayish-brown silty clay about 6 inches thick. The subsoil is dark-gray silty clay about 33 inches thick. The substratum is black silty clay that extends to a depth of more than 60 inches.

These soils are always moist. They are subject to inundation by high tides. The water table is high to very high. Roots of hydrophytic plants can penetrate to a depth of 8 to 24 inches. Permeability is slow, and the available water capacity is 0.5 to 3 inches.

Reyes soils are used for wildlife habitat and recreation areas.

Representative profile of Reyes silty clay, on a tidal flat 2,000 feet north of Parr Boulevard and 2,400 feet west of Goodrick Road. (Color is for moist soil unless otherwise noted.)

A1—0 to 6 inches, very dark grayish-brown (2.5Y 3/2) silty clay; black (N 2/0) organic stains; very weak, very coarse, prismatic structure; slightly sticky and slightly plastic; many very fine, fine, and medium roots; many, very fine and fine, interstitial pores; moderately alkaline; gradual, smooth boundary.

B21g—6 to 22 inches, dark-gray (N 4/0) silty clay; very dark gray (N 3/0) organic stains; weak, very coarse, blocky structure; sticky and plastic; many very fine, fine, and medium roots; many, fine and very fine, tubular pores; moderately alkaline; diffuse, smooth boundary.

B22g—22 to 39 inches, dark-gray (N 4/0) silty clay; streaks of very dark gray (N 3/0); weak, very coarse, blocky structure; sticky and plastic; common very fine and fine roots; few, very fine, tubular pores; moderately alkaline; clear, smooth boundary.

C—39 to 60 inches, black (N 2/0) silty clay that becomes grayish brown (2.5Y 5/2) when exposed to air; massive; very few fine roots; moderately alkaline; extremely acid when treated with hydrogen peroxide.

The A horizon is very dark grayish brown, grayish brown, or light gray.

The B horizon is heavy silty clay loam, silty clay, or clay. It has streaks of brownish yellow, black or dark gray. The quantity of plant remains and humus varies in the B horizon. The C horizon is black or very dark gray.

The profile is highly saline. An odor of hydrogen sulfide can be detected when hydrochloric acid is applied to all horizons. The C horizon contains polysulfides and becomes extremely acid when drained or exposed to wetting and drying.

Ra—Reyes silty clay. This is the only Reyes soil mapped in the county. Included with it in mapping are areas of Joice muck along the upper boundary of the saltwater intrusion into Suisun Bay that make up as much as 15 percent of the mapping unit. Also included are small areas where 20 to 40 inches of silty clay loam or loam fill have been deposited. These areas are slightly better drained than Reyes silty clay. A few areas that lack polysulfides are also included.

Runoff is very slow, and there is no hazard of erosion. Most areas are subject to inundation during high tides.

This soil is used for wildlife habitat and recreation areas. Capability unit VIIIw–1(16).

Rincon Series

The Rincon series consists of well-drained soils mainly on benches. These soils formed in alluvial valley fill from sedimentary rock. Slopes are 0 to 15 percent. Elevation ranges from 50 to 500 feet. The average annual air temperature is 59° F., and the frost-free season is 260 to 300 days. The average annual precipitation is 12 to 16 inches. These soils are moist to a depth of 20 inches from November to May and are dry throughout from June to October in most years. Vegetation is annual grasses, forbes, and scattered oaks.

In a representative profile the surface layer is dark grayish-brown, neutral clay loam about 12 inches thick. The upper part of the subsoil is brown, neutral or mildly alkaline clay about 17 inches thick. The lower part of the subsoil is yellowish-brown, moderately alkaline silty clay loam about 9 inches thick. The substratum is light yellowish-brown, moderately alkaline silty clay loam and heavy loam. It extends to a depth of more than 60 inches.

Permeability is slow, and the available water capacity is 7 to 10 inches. Roots can penetrate to a depth of 42 to more than 60 inches.

Rincon soils are used for irrigated nut crops, fruit, row crops, and forage crops and for dryland pasture, hay, grain, and range.

Representative profile of Rincon clay loam, 0 to 2 percent slopes, south of Lone Tree Way in SW¼NW¼SE¼ sec. 3, T. 1 N., R. 2 E.

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; massive; extremely hard, firm, sticky and plastic; common very fine roots; common, very fine and medium, tubular and interstitial pores; neutral; abrupt, smooth boundary.

A12—6 to 12 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; weak, medium and coarse, angular blocky structure; extremely hard, firm, sticky and plastic; common very fine roots; few, very fine, tubular pores; neutral; clear, wavy boundary.

B21t—12 to 22 inches, brown (10YR 4/3) clay, dark brown (10YR 3/3) when moist; moderate, medium and coarse, angular blocky structure; extremely hard, very firm, sticky and very plastic; common very fine roots; few, very fine, tubular pores; common thin clay films lining pores and on ped faces; neutral; clear, wavy boundary.

B22t—22 to 29 inches, brown (10YR 5/3) clay, dark brown and dark yellowish brown (10YR 3/3 and 4/4) when moist; moderate, medium and coarse, angular blocky structure; extremely hard, very firm, sticky and very plastic; few very fine roots; few, very fine, tubular pores; many clay films lining pores and on ped faces; mildly alkaline; clear, wavy boundary.

B3ca—29 to 38 inches, yellowish-brown (10YR 5/4) silty clay loam, dark yellowish brown (10YR 4/4) when moist; moderate, fine, angular blocky structure; very hard, firm, sticky and plastic; very few very fine roots; few, very fine, tubular pores; common thin clay films lining pores and on ped faces; moderately alkaline; slightly effervescent; disseminated lime and few soft masses of lime; clear, wavy boundary.

C1ca—38 to 55 inches, light yellowish-brown (10YR 6/4) silty clay loam, dark yellowish brown (10YR 4/4) when moist; moderate, fine, angular blocky structure; very hard, friable, sticky and plastic; very few very fine roots; few very fine pores; few thin clay films lining pores and on ped faces; moderately alkaline; slightly effervescent; few soft masses of lime; clear, wavy boundary.

C2ca—55 to 65 inches, light yellowish-brown (10YR 6/4) heavy loam; moderate, fine, angular blocky structure; hard, friable, sticky and slightly plastic; no roots; common, very fine, tubular pores; very few thin clay films lining pores and on ped faces; moderately alkaline; strongly effervescent; disseminated lime and soft masses of lime.

The A horizon is 10 to 18 inches thick. It is dark grayish-brown or brown clay loam, light clay loam, or heavy clay loam. It is slightly acid to mildly alkaline.

The B2t horizon is 13 to 21 inches thick. It is brown or dark yellowish-brown heavy clay loam or clay and has a clay content of 35 to 45 percent. It is neutral to moderately alkaline, and the B22t horizon is calcareous in places.

The C horizon is light yellowish brown, yellowish brown, or brown and is loam, clay loam, or silty clay loam.

RbA—Rincon clay loam, 0 to 2 percent slopes. This nearly level soil formed in valley fill. It has the profile described as representative of the series.

Included with this soil in mapping are areas of Brentwood clay loam that make up about 5 percent of the mapping unit. Also included are areas of Capay clay that make up 5 percent and areas of San Ysidro loam that make up 2 percent.

Runoff is slow and the hazard of erosion is none to slight where the soil is tilled and exposed. Roots can penetrate to a depth of more than 60 inches. The available water capacity is 9 to 10 inches.

This soil is used mainly for irrigated nut crops, fruit, row crops, and forage crops. Capability unit IIs–3(17).

RbC—Rincon clay loam, 2 to 9 percent slopes. This gently sloping and moderately sloping soil is on benches. Included with it in mapping are small areas of Capay clay that make up about 5 percent of the mapping unit and small areas of Antioch loam that make up 5 percent. Also included are soils on alluvial fans. These soils have a surface layer of dark reddish-brown, neutral sandy loam and a subsoil of reddish-brown, neutral clay loam. They have slopes of 3 to 5 percent.

Runoff is medium and the hazard of erosion is slight where the soil is tilled and exposed. Roots can

penetrate to a depth of more than 60 inches. The available water capacity is 9 to 10 inches.

This soil is used mainly for dryland grain and volunteer hay. A few areas are used for range. Capability unit IIe–3 (17).

RbD—Rincon clay loam, 9 to 15 percent slopes. This strongly sloping soil is on benches. Included with it in mapping are small areas of Capay clay that make up about 5 percent of the mapping unit and small areas of Antioch loam that make up 5 percent. Rincon soils that have slopes of 15 to 30 percent also make up 5 percent.

Runoff is medium to rapid, and the hazard of erosion is moderate to severe where the soil is tilled and exposed. Roots can penetrate to a depth of 60 inches. The available water capacity is 9 to 10 inches.

This soil is used mainly for range. A few areas are used for dryland grain. Capability unit IIe–3 (17).

RcA—Rincon clay loam, wet, 0 to 2 percent slopes. This soil is on the lower edges of valley fill. It has a profile similar to the one described as representative of the series, but an intermittent water table is at a depth of 42 to 55 inches.

Included with this soil in mapping are areas of Brentwood clay loam that make up about 5 percent of the mapping unit. Also included are areas of Capay clay that make up 5 percent and areas of San Ysidro loam that make up 2 percent.

Runoff is slow and there is no hazard of erosion where the soil is tilled and exposed. The depth to which roots can penetrate is limited to 42 to 55 inches by the water table. The available water capacity is 7 to 9 inches.

This soil is used mainly for irrigated row crops. Most areas are artificially drained. Capability unit IIw–2 (17).

Rindge Series

The Rindge series consists of very poorly drained organic soils that formed in marshes. These soils are on the Sacramento-San Joaquin Delta. Slopes are 0 to 2 percent. Elevation ranges from 5 to 15 feet below sea level. The average annual air temperature is 59° F., and the frost-free season is 250 to 310 days. The average annual rainfall is 12 to 16 inches. The native vegetation is reeds and tules.

In a representative profile the surface layer is very dark brown, very strongly acid muck about 14 inches thick. The next layer is very dark gray, very strongly acid muck about 10 inches thick. Below this, to a depth of 60 inches, is black, very strongly acid muck.

Permeability is rapid, and the available water capacity is 10 or more inches. Roots can penetrate to a depth of 50 inches or more. The water table ranges from a depth of about 50 inches during the summer to 12 inches or less during the winter.

Rindge soils are used for irrigated field corn, milo, asparagus, tomatoes, and pasture.

Representative profile of Rindge muck, on Holland Tract approximately 120 feet south of a main drainage ditch and 400 feet west of the Old River Levee in SW¼NW¼SW¼ sec. 30 (projected), T. 2 N., R. 4 E. (Color is for moist soil unless otherwise noted; pH by 0.01M CaCl2.)

Oap—0 to 6 inches, very dark brown (10YR 2/2) muck, very dark brown (10YR 2/2) when rubbed; less than 2 percent undisturbed fibers, none when rubbed; moderate, medium, granular structure: soft, very friable, nonsticky and nonplastic; common, very fine roots; very strongly acid; clear, smooth boundary.

Oa2—6 to 14 inches, very dark brown (10YR 2/2) muck, very dark brown (10YR 2/2) when rubbed; less than 2 percent undisturbed fibers, none when rubbed; pockets 3 to 4 inches in diameter of reddish-brown (5YR 4/4) fibers throughout, occupying 10 to 15 percent of cross-section area; content of undisturbed fibers in pockets is 45 percent, less than 10 percent when rubbed; weak, medium, subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common very fine roots; very strongly acid; gradual, smooth boundary.

Oa3—14 to 24 inches, very dark gray (10YR 3/1) muck, black (5YR 2/1) when rubbed; about 15 percent dark yellowish-brown (10YR 4/4 and 3/4) undisturbed fibers, none when rubbed; few, medium, dark reddish-brown (5YR 2/2) coatings on ped faces; weak, thick, platy structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and fine roots; very strongly acid; abrupt, smooth boundary.

Oa4—24 to 42 inches, black (N 2/0) muck, black (N 2/0) when rubbed; 30 percent undisturbed fibers, 5 percent when rubbed; massive; slightly hard, very friable, slightly sticky and slightly plastic; slight odor of hydrogen sulfide; very strongly acid; gradual, smooth boundary.

Oa5—42 to 60 inches, black (10YR 2/1) muck, black (10YR 2/1) when rubbed; 35 percent undisturbed fibers, 5 percent when rubbed; massive; slightly hard, very friable, slightly sticky and slightly plastic; slight odor of hydrogen sulfide; very strongly acid.

The Oap and Oa2 horizons are very dark brown, very dark gray, or black in hues of 10YR and 7.5YR. The structure varies with the degree of tillage. It is granular in intensively tilled areas and subangular blocky in other areas. In the Oa2 horizon, the content of unrubbed fibers is 0 to 10 percent. All of these fibers break down when rubbed. The Oap and Oa2 horizons are very strongly acid to medium acid.

The Oa3 horizon is black to very dark reddish brown in hues of 10YR, N, and 5YR. Values are 2 or 3 and chromas are 1 or 2. The Oa3 horizon has platy or subangular blocky structure. The content of unrubbed organic fibers is 10 to 30 percent, and the content of rubbed fibers is 0 to 5 percent.

The Oa4 and Oa5 horizons are black in hues of 10YR and N. The content of unrubbed fibers is 25 to 50 percent. These horizons are very strongly acid or strongly acid.

Depth to mineral material is more than 52 inches. The organic-matter content is more than 15 percent in the surface layer and commonly increases with depth. Thin strata of organic material that contain more than 10 percent rubbed fibers are commonly near a depth of 50 inches, but these strata total less than 10 inches in thickness.

Rd—Rindge muck. This level or nearly level soil is the only Rindge soil mapped in the county. Included with it in mapping are areas of Webile muck that make up about 5 percent of the mapping unit and areas of Kingile muck that make up 4 percent. Included on the Holland tract are areas of soils that are underlain by coarse sand between depths of 36 to 52 inches. These areas make up 4 percent. Also included are areas of a soil that is similar to Rindge muck but that contains more than 10 inches of less-

decomposed organic material. These areas make up 2 percent.

Runoff is very slow. Soil blowing is a moderate hazard where the soil is tilled and exposed. This soil is subject to peat fires during summer. When allowed to dry, this soil shrinks irreversibly. It will repel water when allowed to air dry.

This soil is used mainly for row crops, especially corn. Other row crops include asparagus, milo, and tomatoes. Some small areas are in permanent pasture. Other small areas are flooded during part of the year to provide wildlife habitat. Capability unit IIIw–10(16).

Rock Outcrop

Rock outcrop is exposed bedrock. In this county it is mapped in a complex with Lodo soils and in an association with Xerorthents.

Re—Rock outcrop-Xerorthents association. This association consists of about 50 to 75 percent rock outcrops and 25 to 50 percent Xerorthents. Slopes range from 30 to 75 percent, but are mostly 50 to 75 percent. Elevation ranges from 1,000 to 3,849 feet. The average annual temperature is 59° F., and the frost-free season is 240 to 280 days. The average annual rainfall is 20 to 25 inches.

The Xerorthents are mainly loamy soils less than 4 inches deep, but in a few areas they are as much as 10 inches deep. They are typically loam but are silt loam or light clay loam in places. Reaction is medium to neutral. Xerorthents are excessively drained. The hazard of erosion is very severe where they are bare. Permeability is moderate, and the available water capacity is less than 1.5 inches.

The association is used for wildlife habitat and watershed. A few areas are used for range. Capability unit VIIIe–1(15).

Ryde Series

The Ryde series consists of very poorly drained soils. These soils are on the Sacramento-San Joaquin Delta. Slopes are 0 to 2 percent. Elevation ranges from 5 feet above sea level to 10 feet below sea level. The average annual air temperature is 59° F., and the frost-free season is 260 to 300 days. The average annual rainfall is 12 to 16 inches. Vegetation is tules, reeds, and sedges.

In a representatative profile the surface layer is mottled, gray, medium acid silt loam about 25 inches thick. The substratum is pale-brown and gray, medium acid, heavy silt loam and light clay loam that is stratified with thin layers of sandy loam and organic material. It extends to a depth of more than 60 inches.

Permeability is moderate, and the available water capacity is 6 to 8 inches. Depth to the water table ranges from a depth of 40 to 50 inches during the growing season and to within a foot of the surface during winter. Roots can penetrate to a depth of 40 to 50 inches.

Ryde soils are used for irrigated field corn, milo, tomatoes, asparagus, and pasture.

Representative profile of Ryde silt loam, on Palm Tract about 925 feet west of the Old River and 3,175 feet south of Rock Slough in SE¼SE¼NW¼ sec. 6, T. 1 N., R. 4 E.

Ap—0 to 12 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) when moist; common, medium, prominent, red (2.5YR 4/8) mottles; moderate, medium, subangular blocky structure parting to very fine subangular blocky; slightly hard, friable, slightly sticky and plastic; many, very fine and fine, random, inped roots; common, very fine, discontinuous, tubular pores; medium acid; abrupt, smooth boundary.

A12—12 to 25 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) when moist; common, fine, distinct, yellowish-red (5YR 5/8) mottles; moderate, medium, subangular blocky structure parting to very fine subangular blocky; slightly hard, friable, slightly sticky and plastic; few, very fine and fine, random, inped roots; few, very fine, discontinuous, tubular pores; medium acid; clear, smooth boundary.

Ab—25 to 32 inches, pale-brown (10YR 6/3) silt loam, grayish brown (10YR 5/2) when moist; common, fine, prominent, dark-red (2.5YR 3/6) mottles and few, fine, distinct, strong-brown (7.5YR 5/6) mottles; moderate, thick, platy structure; slightly hard, very friable, slightly sticky and plastic; very few very fine roots; very few, very fine, discontinuous, tubular pores; medium acid; stratified with thin layers (½ inch thick) of dark-brown (7.5 YR 3/2) organic material; thin layers contain approximately 20 percent undisturbed fibers, none when rubbed; clear, smooth boundary.

IIC1—32 to 48 inches, gray (10YR 5/1) heavy silt loam, very dark gray (10YR 3/1) when moist; common, coarse and medium, prominent mottles; 10 percent of mottles are glossy; weak, coarse, subangular blocky structure; hard, friable, sticky and plastic; very few very fine roots; very few, very fine, tubular pores; medium acid; stratified with thin layers (1 inch thick) of grayish-brown (10YR 5/2) sandy loam; gradual, smooth boundary.

IIC2—48 to 60 inches, gray (10YR 5/1) light clay loam, very dark grayish brown (10YR 3/2) when moist; massive; hard, firm, sticky and plastic; medium acid; small organic fibers (1 inch long) spread at random through the matrix.

The A horizon is 20 to 30 inches thick. It is gray, grayish brown, very dark gray, or very dark grayish brown in hues of 10YR or 2.5Y. Moist values are 2 or 3. The A horizon is loam or silt loam and is medium acid or slightly acid.

The Ab horizon is 0 to 10 inches thick. It is loam, silt loam, or clay loam and is medium acid or slightly acid.

The IIC horizon is gray or dark gray in hues of 10YR through 5Y. Gleyed colors of greenish gray (5GY 5/1 and 5G 5/1) are at a depth of more than 36 inches in places.

Distinct or prominent mottles are present throughout. The content of mica flakes ranges from 0 to 10 percent, and mica flakes occur in all horizons. In places irreversible cracks less than 1 inch wide appear at a depth of 15 to 25 inches and extend to a depth of 40 inches. In some areas seams of gypsum are at a depth of 12 to 25 inches. Between depths of 24 and 40 inches, organic matter is in thin, discontinuous layers of fiber or in black or very dark gray, carbon-like blotches. In some places, organic material that contains 20 to 50 percent unrubbed fibers and less than 10 percent rubbed fibers is at a depth of more than 40 inches.

Rh—Ryde silt loam. This level or nearly level soil is the only Ryde soil mapped in the county. Included with it in mapping are Kingile muck, generally mapped near areas of Kingile soils, and Egbert silty clay. Each of these soils makes up about 4 percent of

the mapping unit. Also included are areas where the soils have been leveled over an organic soil, resulting in a mineral soil similar to Ryde silt loam overlying an organic soil at a depth of 20 to 40 inches. Most of these areas are on Palm Tract, and they make up 4 percent of the mapping unit. Areas of Rindge muck that make up 3 percent are also included.

Runoff is very slow, and there is no hazard of erosion where the soil is tilled and exposed.

Most areas of this soil have been leveled and are used for irrigated field corn, milo, tomatoes, asparagus, and pasture. Capability unit IIIw–2(16).

Sacramento Series

The Sacramento series consists of poorly drained and very poorly drained soils that formed in mixed alluvium. These soils are adjacent to the organic soils on the Sacramento-San Joaquin Delta. Slopes are 0 to 2 percent. Elevation ranges from near sea level to 60 feet. The average annual air temperature is 59° F., and the frost-free season is 260 to 300 days. The average annual rainfall is 12 to 16 inches. Native vegetation is annual grasses and forbs.

In a representative profile the surface layer extends to a depth of about 41 inches. It is very dark gray, slightly acid clay in the upper 9 inches. In the next 9 inches, it is very dark gray, neutral clay that has distinct, dark yellowish-brown mottles. In the lower 23 inches, it is mottled dark-gray, very dark gray, gray, olive-brown, and yellowish-brown, moderately alkaline clay. The substratum is mottled gray and olive-brown, moderately alkaline clay that extends to a depth of more than 60 inches.

Permeability is slow, and the available water capacity is 5 to 9 inches. Depth to the water table is 4 to 5 feet. Roots can penetrate to a depth of 36 to 60 inches.

Sacramento soils are used mainly for irrigated row crops. Most of these areas have been leveled. Some areas are used for irrigated pasture.

Representative profile of Sacramento clay, 2 miles east of Byron in NE¼NE¼NE¼ sec. 11, R. 3 E., T. 1 E. (The profile was moist when examined, and water table was at a depth of 48 inches.)

A11—0 to 9 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) when moist; moderate, coarse, prismatic structure parting to moderate, medium, angular blocky; very hard, very firm, sticky and very plastic; few fine and many very fine roots; common, very fine, tubular pores; slightly acid; abrupt, smooth boundary.

A12—9 to 18 inches, very dark gray (10YR 3/1) clay, black (N 2/0) when moist; common, fine, distinct, dark yellowish-brown (10YR 4/4) mottles, olive brown (2.5YR 4/4) when moist; moderate, coarse, prismatic structure parting to moderate, medium, angular blocky; very hard, very firm, sticky and very plastic; very few fine roots and common very fine roots; common, very fine, tubular pores; neutral; gradual, smooth boundary.

A13ca—18 to 24 inches, mottled dark-gray (N 4/0), very dark gray (5Y 3/1), and olive-brown (2.5Y 4/4) clay, mottled black (5Y 2/1), very dark gray (N 3/0), and olive brown (2.5Y 4/4) when moist; moderate, coarse, angular blocky structure; very hard, very firm, sticky and very plastic; common very fine roots; many, very fine, tubular pores; moderately alkaline; seams of gypsum; clear, smooth boundary.

A14ca—24 to 41 inches, mottled gray (5Y 5/1), olive-brown (2.5Y 4/4), and yellowish-brown (10YR 5/4) clay, mottled dark gray (5Y 4/1) and olive brown (2.5Y 4/4) when moist; weak, moderate, angular blocky structure; very hard, very firm, sticky and very plastic; common very fine roots; common, very fine, tubular pores; moderately alkaline; strongly calcareous; lime in filaments; clear, smooth boundary.

C—41 to 60 inches, mottled gray (5Y 5/1) and olive-brown (2.5Y 4/4) clay, mottled black (5Y 2/1) and olive brown (2.5Y 4/4) when moist; massive; hard, firm, sticky and plastic; very few very fine roots; very few, very fine, tubular pores; moderately alkaline; slightly calcareous; irregular lime concretions.

The A11 horizon is dark gray or very dark gray in hues of 10YR and 2.5Y and has moist values of 2 or 3. The A horizon is slightly acid to moderately alkaline, and the upper 20 inches is noncalcareous in some places.

The C horizon is clay or silty clay. It is mildly alkaline or moderately alkaline and is normally calcareous.

Distinct or prominent mottles are within a depth of 9 inches and throughout the profile. Cracks at least ½ inch wide extend to a depth of 20 inches or more. The estimated clay content of the upper 40 inches averages more than 60 percent. Some slickensides are present in places, but they do not intersect.

Sa—Sacramento clay. This nearly level soil has the profile described as representative of the series. Included with it in mapping are small areas of Marcuse clay that make up about 5 percent of the mapping unit and areas of Egbert clay, adjacent to the organic soils, that make up 5 percent. Also included are areas less than ½ acre in size of soils that have a surface layer of sandy clay that gradually grades into sand or loamy sand. These areas make up less than 1 percent. Areas of soils that have a surface layer of clay loam make up 2 percent, and a few small areas of soils that are calcareous throughout are also included.

This poorly drained soil has been artificially drained, and the water table has been lowered to a depth of 4 to 5 feet. Most areas are protected by levees. Runoff is slow, and there is no hazard of erosion. Roots can penetrate to a depth of 48 to 60 inches. The available water capacity is 7 to 9 inches.

This soil is used mainly for irrigated row crops. Most of these areas have been leveled. Some areas are used for irrigated pasture. Capability unit IIIw–5(16).

Sb—Sacramento clay, alkali. This nearly level soil has a profile similar to the one described as representative of the series, but it contains enough saline and alkali salts to limit the selection of crops. About 5 to 25 percent of the area is unsuited to most crops.

Included with this soil in mapping are small areas of Marcuse clay that make up about 8 percent of the mapping unit. Also included are small areas of soils that have a surface layer of sandy clay that gradually grades into sand or loamy sand. These areas make up 5 percent. Areas of soils that have a surface layer and substratum of dark-brown clay loam or loam make up 2 percent.

This soil is very poorly drained, but the water table has been lowered to a depth of 36 to 60 inches by reclamation. Runoff is slow, and there is no hazard of

erosion. Roots can penetrate to a depth of 36 to 60 inches. The available water capacity is 5 to 7 inches.

This soil is used for irrigated pasture and some row crops. Capability unit IVw–6(17).

San Ysidro Series

The San Ysidro series consists of moderately well drained soils that formed in alluvium from sedimentary rock. These soils are on old alluvial fans and floors of valleys. Slopes are 0 to 2 percent. Elevation is less than 1,000 feet. The average annual air temperature is 60° F., and the frost-free season is 260 to 300 days. The average annual rainfall is 10 to 12 inches. These soils are moist to a depth of 20 inches from November to June and are dry from late in June to mid-October or November. Vegetation is annual grasses and forbs.

In a representative profile the surface layer is about 15 inches thick. It is light brownish-gray, slightly acid loam in the upper 8 inches and brown, slightly acid clay loam in the lower 7 inches. The subsoil extends to a depth of 54 inches. It is brown, neutral and moderately alkaline clay in the upper 19 inches and yellowish-brown, moderately alkaline silty clay in the lower 20 inches. The substratum is yellowish-brown, strongly calcareous, silty clay loam that extends to a depth of more than 60 inches.

Permeability is very slow, and the available water capacity is 3.5 to 5 inches. The depth to which roots can penetrate is limited to 10 to 20 inches by the clay subsoil. Some water that perches above the clay subsoil is available to plants.

San Ysidro soils are used mainly for range. Some areas are used for dryfarmed barley and irrigated pasture.

Representative profile of San Ysidro loam, 140 feet east of Bruns Road and 175 feet north of an unnamed gravel road in SW¼SW¼SW¼ sec. 25, T. 1 S., R. 3 E.

Ap—0 to 8 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; massive; hard, friable, slightly sticky and slightly plastic; many very fine roots; common, very fine, tubular pores; slightly acid; abrupt, smooth boundary.

A12—8 to 15 inches, brown (10YR 4/3) clay loam, brown (10YR 4/3) when moist; massive; hard, friable, sticky and plastic; common very fine roots; many, very fine, tubular pores; slightly acid; abrupt, wavy boundary.

B21t—15 to 27 inches, brown (7.5YR 4/4) clay, brown (10YR 4/3) when moist; moderate, medium, columnar structure parting to moderate, medium, angular blocky; tops of columns appear to be bleached; extremely hard, very firm, sticky and very plastic; few very fine roots; common, very fine, tubular pores; continuous moderately thick clay films lining pores and on ped faces; neutral; gradual, smooth boundary.

B22t—27 to 34 inches, brown (10YR 4/3) clay, brown (10YR 4/3) when moist; moderate, medium, prismatic structure parting to moderate, medium, angular blocky; extremely hard, very firm, sticky and very plastic; very few very fine exped roots; common, very fine, tubular pores; continuous moderately thick clay films lining pores and on ped faces; moderately alkaline; clear, smooth boundary.

B3t—34 to 54 inches, yellowish-brown (10YR 5/4) silty clay, yellowish brown (10YR 5/6) when moist; moderate, medium, angular blocky structure; very hard, firm, sticky and plastic; very few fine roots; common very fine pores; many moderately thick clay films lining pores and on ped faces; moderately alkaline; gradual, wavy boundary.

Cca—54 to 80 inches, yellowish-brown (10YR 5/6) silty clay loam, yellowish brown (10YR 5/6) when moist; massive (augered); hard, friable, sticky and plastic; moderately alkaline; strongly calcareous; lime is segregated and disseminated.

The A horizon is 10 to 20 inches thick. It is light brownish gray, brown, or pale brown. Moist values are 4 or more. The upper part of the A horizon is fine sandy loam, loam, or silt loam. In some places the lower part of the A horizon is clay loam.

The B2t horizon is 8 to 26 inches thick. It is brown, yellowish brown, dark brown, or light yellowish brown. It is typically clay and has at least 15 percent more clay than the A horizon. It has columnar, prismatic, or angular blocky structure and is slightly acid to moderately alkaline. The B3 horizon is clay loam, clay, or silty clay.

The C horizon is loam or silty clay loam. It is mildly alkaline or moderately alkaline.

The clay content between depths of 10 and 40 inches averages 35 to 50 percent, and the clay is dominantly montmorillonite.

Sc—San Ysidro loam. This is the only San Ysidro soil mapped in the county. It has slopes of 0 to 2 percent.

Included with this soil in mapping are Solano loam and Rincon clay loam, each of which makes up about 5 percent of the mapping unit. Also included are areas of San Ysidro loam that have slopes of 2 to 5 percent.

Runoff is slow, and the hazard of erosion is slight.

This soil is used mainly for range. Some areas are cultivated and are used for barley or irrigated pasture. Capability unit IIIs–3(17); Claypan range site.

Sehorn Series

The Sehorn series consists of well-drained soils underlain by neutral, soft shale. These soils are on uplands. Slopes are 15 to 75 percent. Elevation ranges from 200 to 1,500 feet. The average annual air temperature is about 57° F., and the frost-free season is 260 to 300 days. The average annual rainfall is 15 to 25 inches. Vegetation is annual grasses, forbs, and scattered oaks and laurel trees.

In a representative profile the surface layer is grayish-brown, slightly acid clay about 25 inches thick. Below this is grayish-brown, neutral silty clay that is underlain at a depth of about 35 inches by soft, weathered shale.

Permeability is slow, although water runs rapidly down open cracks before the soil becomes moist and swells and the cracks close. The available water capacity is 3.5 to 8 inches. Roots can penetrate to a depth of 20 to 40 inches.

Most areas of Sehorn soils are used for range. Some areas are used for irrigated pasture and dryland barley.

Representative profile of Sehorn clay, 30 to 50 percent slopes, about 1 mile west of the Rocky Ridge relay station in SE¼NE¼NE¼ sec. 28, T. 1 S., R. 2 W.

A11—0 to 10 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; upper 2

inches has strong, fine, subangular blocky structure, and the rest has strong, coarse, prismatic; very hard, firm, slightly sticky and plastic; common, very fine, exped roots; few, very fine, tubular pores; slightly acid; clear, wavy boundary.

A12—10 to 25 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; strong, coarse and very coarse, prismatic structure; very hard, firm, slightly sticky and plastic; common, very fine, exped roots; few, very fine, tubular pores; common intersecting slickensides; slightly acid; clear, wavy boundary.

AC—25 to 35 inches, grayish-brown (2.5Y 5/2) silty clay, same color when moist; weak, coarse, subangular blocky structure; hard, friable, sticky and plastic; few very fine roots; common, very fine, tubular pores; few intersecting slickensides; olive-gray (5Y 4/2) shale fragments less than 5 millimeters in diameter make up about 20 percent, by volume; neutral; clear, irregular boundary.

Cr—35 to 48 inches, olive-gray, soft, shattered shale; dark-brown stains on faces of fragments.

The A horizon is light brownish gray, pale brown, grayish brown, or brown (10YR 6/2, 6/3, 5/2, 5/3, 2.5Y 6/2, or 5/2). It is heavy clay loam, heavy silty clay loam, silty clay, or clay. Intersecting slickensides are in the lower part of the A horizon and the AC horizon.

Depth to shale ranges from 20 to 40 inches. Cracks more than 1 centimeter wide extend to a depth of more than 20 inches. These cracks are open from June to October or November in most years. They open and close only once each year.

SdE—Sehorn clay, 15 to 30 percent slopes. This moderately steep soil is on ridges. Included with it in mapping are small areas of Los Gatos loam and of Los Osos clay loam that are on toe slopes and that support stands of oak and laurel. Each of these soils makes up about 4 percent of the mapping unit. Also included are areas of Altamont clay that make up 4 percent and areas of Millsholm loam on ridgetops and near rock outcrops that make up 3 percent.

Runoff is medium, and the hazard of erosion is moderate where the soil is bare. Roots can penetrate to a depth of 25 to 40 inches. The available water capacity is 4.5 to 8 inches.

This soil is used mainly for range. Some areas are in irrigated pasture and dryland barley. Some small areas near St. Mary's College are used for urban purposes. Capability unit IVe–5(15) ; Clayey range site.

SdF—Schorn clay, 30 to 50 percent slopes. This steep soil is on ridges and hills. It has the profile described as representative of the series.

Included with this soil in mapping are areas of Millsholm loam near ridgetops and rock outcrops, areas of Los Gatos loam, and small areas of Altamont clay over calcareous, soft shale. Each of these soils makes up about 2 percent of the mapping unit. Also included are areas of Los Osos clay loam that make up 4 percent.

Runoff is medium to rapid, and the hazard of erosion is moderate to high where the soil is bare. Roots can penetrate to a depth of 25 to 40 inches. The available water capacity is 4.5 to 8 inches.

This soil is used for range. Capability unit VIe–1(15) ; Clayey range site, steep.

SdG—Sehorn clay, 50 to 75 percent slopes. This very steep soil is on ridges. It has a profile similar to the one described as representative of the series, but depth to shale ranges from 20 to 35 inches.

Included with this soil in mapping are areas of Millsholm loam near ridgetops and rock outcrops, areas of Los Gatos loam, and small areas of Altamont clay over calcareous, soft shale. Each of these soils makes up about 2 percent of the mapping unit. Also included are areas of Los Osos clay loam that make up 4 percent.

Runoff is very rapid, and the hazard of erosion is high where the soil is bare. Roots can penetrate to a depth of 20 to 35 inches. The available water capacity is 3.5 to 7 inches.

This soil is used for range. Capability unit VIIe–1(15) ; Clayey range site, very steep.

Shima Series

The Shima series consists of very poorly drained organic soils underlain by sand at a depth of less than 36 inches. These soils are in marshes on the Sacramento-San Joaquin Delta. They formed mainly from the remains of reeds and tules. Slopes are less than 1 percent. Elevation is slightly below sea level. The average annual air temperature is about 60° F., and the frost-free season is 260 to 310 days. The average annual rainfall is 12 to 14 inches.

In a representative profile the soil is black, very strongly acid muck in the upper 21 inches. The upper 4 inches of the substratum is black, very strongly acid silty clay. This is underlain abruptly by mottled, dark-gray, very strongly acid sand and dark greenish-gray, moderately alkaline sand that extends to a depth of more than 60 inches.

Permeability is rapid, and the available water capacity is 6 to 10 inches. The water table is at a depth of 24 to 48 inches. The depth to which roots can penetrate is limited to 16 to 35 inches by the sand substratum.

Shima soils are used for irrigated pasture, corn, asparagus, tomatoes, and milo and for dryland barley.

Representative profile of Shima muck, on Holland Tract, about 600 feet north of Rock Slough in NE¼SE¼NW¼ sec. 36, T. 2 N., R. 3 E. (projected). (Color is for moist soil. Reaction is determined in 0.01 M/calcium chloride.)

Oap—0 to 8 inches, black (10YR 2/1) on broken face, rubbed and pressed muck; less than 2 percent fibers, none when rubbed; moderate, medium, granular structure; soft, very friable, slightly sticky and nonplastic; many, fine and very fine roots; very strongly acid; abrupt, smooth boundary.

Oa2—8 to 17 inches, black (5YR 2/1) on broken face, rubbed and pressed muck; about 10 percent fibers, less than 2 percent when rubbed; moderate, thick, platy structure; slightly hard, very friable, slightly sticky and nonplastic; common, fine and very fine roots; appears to be dense and irreversibly dried; very strongly acid; clear, smooth boundary.

Oa3—17 to 21 inches, black (10YR 2/1) on broken face, rubbed and pressed muck; less than 2 percent fibers, none when rubbed; weak, medium, subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine

and very fine roots; very strongly acid; clear, smooth boundary.

C1—21 to 25 inches, black (10YR 2/1) light silty clay; weak, medium, angular blocky structure; hard, firm, sticky and plastic; few very fine roots; few very fine pores; very strongly acid; abrupt, smooth boundary.

IIC2—25 to 45 inches, dark-gray (10YR 4/1) sand; few, medium, prominent, yellowish-brown (10YR 5/6) mottles; single grained; loose when dry and moist, nonsticky and nonplastic; very few very fine roots; many, very fine, interstitial pores; very strongly acid; gradual, smooth boundary.

IIC3—45 to 60 inches, dark greenish-gray (5GY 4/1) sand; single grained; loose when dry and moist, nonsticky and nonplastic; no roots; many, very fine, interstitial pores; moderately alkaline.

The Oap horizon has weak or moderate, subangular blocky or weak or moderate, granular structure. Its content of unrubbed fibers ranges from 0 to 5 percent, and its mineral content ranges from 45 to 75 percent. Reaction is strongly acid or very strongly acid.

The Oa2 horizon ranges from black (10YR 2/1, 5YR 2/1, 2.5Y 2/0, or 2.5Y 2/2) to very dark brown (10YR 2/2 or 7.5YR 2/2) or dark reddish brown (5YR 2/2). Its structure ranges from weak or moderate, platy to weak or moderate, subangular blocky. The content of unrubbed fibers ranges from 0 to 10 percent, and the content of rubbed fibers ranges from 0 to 5 percent. Mineral content ranges from 30 to 65 percent. The Oa2 horizon is strongly acid or very strongly acid. In places, small pockets of gypsum are present in this horizon.

Where present, the Oa3 horizon is black or dark brown and is massive or has weak, medium, subangular blocky structure. Mineral content ranges from 50 to 75 percent. Reaction is strongly acid or very strongly acid.

The C horizon is clay loam, light silty clay, sandy clay, or clay. It is strongly acid or very strongly acid. The IIC horizon ranges from sand to loamy sand. The IIC2 horizon is not present in some places.

Depth to mineral layers ranges from 16 to 35 inches. Cracks ½ inch wide are normally present in the Oa2 and Oa3 horizons except where the soils are plowed to the mineral substratum. The weighted average clay content of the mineral horizons to a depth of 51 inches ranges from 4 to 10 percent.

Se—Shima muck. This soil is generally level or nearly level, but in many areas it is very gently undulating. It is the only Shima soil mapped in the county.

Included with this soil in mapping are small circular areas less than 5 acres in size of Piper soils that make up about 10 percent of the mapping unit. Also included in some areas of deeper Shima soils are small areas of Webile soils that make up 2 percent.

Runoff is very slow. There is no hazard of erosion while the soil is wet in winter, but the hazard of soil blowing is moderate in summer. Some areas of this soil are susceptible to peat fires late in summer.

This soil is used mainly for irrigated pasture, corn, asparagus, tomatoes, and milo. Some areas are used for dryland barley. Capability unit IIIw–10 (16).

Solano Series

The Solano series consists of somewhat poorly drained soils that formed in alluvium from sedimentary rock. These soils are on the basin rims of old valley fill. They are severely affected by sodium salts. They have irregular or hummocky microrelief. Slopes are 0 to 2 percent. Elevation ranges from 10 to 150 feet. The average annual air temperature is 60° F., and the frost-free season is 260 to 300 days. The average annual rainfall is 10 to 12 inches. These soils are moist from November to June and are dry from late in June to mid-October or November. The vegetation is mouse barley, saltgrass, saltbush, and other salt-tolerant forbs.

In a representative profile the surface layer is mixed grayish-brown and gray, slightly acid loam about 3 inches thick over mixed grayish-brown and very dark grayish-brown, moderately alkaline clay loam about 6 inches thick. The subsoil is grayish-brown and brown, moderately alkaline and strongly alkaline clay loam and light silty clay loam about 31 inches thick. The substratum is pale-brown, moderately alkaline clay loam that extends to a depth of more than 60 inches.

Permeability is very slow, and the available water capacity is 4 to 6 inches. The water table has been lowered to a depth of 3 to 4 feet by drainage. Roots of salt-tolerant plants can penetrate to a depth of 36 to 48 inches.

Solano soils are used for irrigated pasture and range.

Representative profile of Solano loam, in SE¼SW¼NE¼ sec. 23, R. 3 E., T. 2 S.

A21—0 to 3 inches, mixed grayish-brown (10YR 5/2) and gray (10YR 6/1) loam, dark grayish brown (10YR 4/2) and gray (10YR 5/1) when moist; massive; hard, friable, slightly sticky and slightly plastic; few fine and many very fine roots; common, very fine, tubular pores; slightly acid; clear, smooth boundary.

A22—3 to 9 inches, mixed grayish-brown (10YR 5/2) and very dark grayish-brown (10YR 3/2) clay loam, dark brown (10YR 4/2) and very dark brown (10YR 2/2) when moist; massive; very hard, firm, sticky and plastic; few fine and common very fine roots; many, very fine, tubular pores; moderately alkaline; clear, wavy boundary.

B21t—9 to 18 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, coarse, columnar structure; very hard, firm, sticky and plastic; few fine roots; common, very fine, tubular pores; many thin clay films on ped faces and in pores; moderately alkaline; clear, wavy boundary.

B22t—18 to 25 inches, brown (10YR 5/3) clay loam, brown (10YR 5/3) when moist; moderate, medium, angular blocky structure; very hard, firm, sticky and plastic; very few very fine roots; common, very fine, tubular pores; many thin clay films in pores and on ped faces; strongly alkaline; highly calcareous; lime is disseminated and segregated; gradual, wavy boundary.

B3t—25 to 40 inches, brown (10YR 5/3) light silty clay loam, brown (10YR 4/3) when moist; moderate, medium, angular blocky structure; very hard, firm, sticky and plastic; very few very fine roots; common, very fine, tubular pores; continuous thin clay films in pores and on ped faces; moderately alkaline; slightly calcareous; disseminated lime and concretions of segregated lime; diffuse, wavy boundary.

C—40 to 60 inches, pale-brown (10YR 6/3) clay loam, dark yellowish brown (2.5Y 4/4) when moist; moderate, medium, angular blocky structure; very hard, friable, slightly sticky and plastic; very few very fine roots; common, very fine, tubular pores; few, thin, continuous clay films on ped faces and in pores; moderately alkaline; slightly calcareous; disseminated lime and concretions of segregated lime.

An A1 horizon is present on the tops of mounds and absent in the troughs between mounds. It is commonly massive, brown or grayish-brown loam.

The A2 horizon is 5 to 11 inches thick. It is loam or clay loam and is medium acid to moderately alkaline.

The B2t horizon is 13 to 29 inches thick. It is grayish-brown, brown, or yellowish-brown clay loam or silty clay loam, and its average clay content is less than 35 percent. It contains more than 15 percent exchangeable sodium.

The B3t horizon is 12 to 18 inches thick and is loam, clay loam, or silty clay loam.

Sh—Solano loam. This soil is in old valley fill near rims of basins. Slopes are 0 to 2 percent. The soil has hummocky microrelief. It has the profile described as representative of the series.

Included with this soil in mapping are areas of San Ysidro loam that make up about 10 percent of the mapping unit.

Runoff is slow, and the hazard of erosion is slight.

This soil is used mainly for range. A few areas are used for irrigated pasture. Capability unit IVw–6(17).

Sk—Solano loam, strongly alkali. This soil is in old valley fill near rims of basins. Slopes are 0 to 2 percent. This soil has a profile similar to the one described as representative of the series, but as much as 35 percent of the area is unsuited to most crops because of excess sodium and saline salts.

Included with this soil in mapping are areas of San Ysidro loam that make up about 10 percent of the mapping unit.

Runoff is slow, and the hazard of erosion is moderate.

This soil is used mainly for range. Capability unit used for irrigated pasture. Capability unit VIw–1(17).

Sorrento Series

The Sorrento series consists of well-drained soils that formed in alluvium from sedimentary rock. These soils are in valley fill and on alluvial fans. Slopes are 0 to 2 percent. Elevation ranges from 25 to 150 feet. The average annual air temperature is 59° F., and the frost-free season is 260 to 300 days. The average annual rainfall is 14 to 16 inches. These soils are dry from June to Octoher and are moist from December to June in most years. Vegetation is annual grasses and forbs.

In a representative profile the surface layer is grayish-brown, slightly acid and neutral silty clay loam about 19 inches thick. The substratum is brown, mildly alkaline light silty clay loam to a depth of 39 inches and brown, calcareous very fine sandy loam to a depth of 44 inches. Below this it is grayish-brown, calcareous clay loam that extends to a depth of more than 60 inches.

Permeability is moderately slow, and the available water capacity is 7.5 to 12 inches. Roots can penetrate to a depth of more than 60 inches.

Sorrento soils are used for irrigated barley, alfalfa, row crops, walnuts, apricots, and peaches.

Representative profile of Sorrento silty clay loam, south of Payne Road in NE¼NW¼ sec. 25, T. 1 N., R. 2 E. (projected).

A1p—0 to 6 inches, grayish-brown (10YR 5/2) silty clay loam, dark brown (10YR 3/3) when moist; weak, fine, granular structure; hard, friable, sticky and plastic; common very fine roots; common, very fine and fine, tubular pores; slightly acid; smooth boundary.

A12—6 to 19 inches, grayish-brown (10YR 5/2) silty clay loam, dark brown (10YR 3/3) when moist; weak, fine, granular structure; hard, friable, sticky and plastic; many very fine and common medium roots; many, very fine and common, fine, discontinuous, tnbular pores; neutral; gradual, wavy boundary.

C1—19 to 39 inches, brown (10YR 5/3) light silty clay loam, dark brown (10YR 4/3) when moist; weak, fine, granular structure; hard, friable, sticky and slightly plastic; many very fine, fine, and medium roots; many, very fine and few, fine, tubular pores; mildly alkaline; clear, wavy boundary.

C2ca—39 to 44 inches, brown (10YR 5/3) very fine sandy loam, brown (10YR 4/3) when moist; massive; slightly hard, very friable, nonsticky and nonplastic; many very fine, fine, and medium roots; few, very fine, tubular pores; moderately alkaline; very slightly effervescent; disseminated lime; clear. wavy boundary,

C3ca—44 to 60 inches, grayish-brown (10YR 5/2) clay loam, dark hrown (10YR 3/3) when moist; weak, fine, subangular blocky structure; hard, friable, sticky and plastic; few very fine and fine roots and common medium roots; common, fine, tubular pores; moderately alkaline; slightly effervescent; diffused lime.

The A horizon is grayish brown, dark grayish brown, or brown in hues of 10YR and 2.5Y. Moist values are 3 or less between depths of 10 and 20 inches. The A horizon is loam, silt loam, clay loam, or silty clay loam. It is slightly acid to mildly alkaline.

The C horizon is brown, grayish brown, or light yellowish hrown. It commonly is calcareous in some part above a depth of 40 inches. It is typically clay loam, but it has a few thin lenses of very fine sandy loam or sandy loam in places. In some places it is underlain by sand below a depth of 40 inches.

Sm—Sorrento silty clay loam. This nearly level soil is on terraces and alluvial fans. It has the profile described as representative of the series.

Included with this soil in mapping are areas of Brentwood clay loam that make up about 5 percent of the mapping unit, areas of Garretson loam that make up 3 percent, and areas of Sycamore silty clay loam that make up 4 percent.

Runoff is slow, and the hazard of erosion is none or slight where the soil is tilled and exposed. Roots can penetrate to a depth of more than 60 inches. The available water capacity is 10 to 12 inches.

This soil is used mainly for irrigated walnuts, apricots, tomatoes, and head lettuce. Tomatoes and head lettuce are commonly double cropped with barley. Capability unit I(17).

Sn—Sorrento silty clay loam, sand substratum. This nearly level soil is on alluvial fans. It has a profile similar to the one described as representative of the series, but it is underlain by porous sand below a depth of 40 to 50 inches.

Included with this soil in mapping are Brentwood clay loam, Garretson loam, and Sycamore silty clay loam, each of which makes up about 5 percent of the mapping unit.

This soil has moderately slow permeability in the upper part and rapid permeability in the underlying

sand. Runoff is slow, and the hazard of erosion is none or slight. Roots can penetrate to a depth of more than 60 inches. The available water capacity is 7.5 to 10.5 inches.

This soil is used mainly for irrigated almonds and apricots. Capability unit IIs–0(17).

Sycamore Series

The Sycamore series consists of poorly drained soils that formed in alluvium from sedimentary rock. These soils are on flood plains. Slopes are 0 to 2 percent. Elevation ranges from 10 to 300 feet. The average annual air temperature is 59° F., and the frost-free season is 275 to 300 days. The average annual rainfall is 14 to 18 inches. These soils are rarely dry below a depth of 20 inches. Vegetation is annual grasses and forbs.

In a representative profile the surface layer is grayish-brown, neutral silty clay loam about 15 inches thick. The subsoil is mottled pale-brown, brown, strong-brown, dark grayish-brown, and dark-brown, moderately alkaline silt loam and heavy silt loam that extends to a depth of 27 inches. The substratum is calcareous silty clay loam that is highly mottled in shades of brown. It extends to a depth of more than 60 inches.

Permeability is moderately slow, and the available water capacity is 6 to 11 inches. Roots can penetrate a depth of 40 to 60 inches or more. Natural stream cutting and reclamation have lowered the water table to a depth of 40 to 60 inches.

In the eastern part of the county, Sycamore soils are used for almonds, apricots, and walnuts. In the central part of the county, these soils are used mainly for urban purposes.

Representative profile of Sycamore silty clay loam, about 0.7 mile east of the Santa Fe Railroad and 50 feet south of Cypress Road in NE¼NW¼NW¼SE¼ sec. 20, T. 2 N., R. 3 E.

Ap—0 to 4 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; massive; very hard, friable, sticky and plastic; few very fine, fine, and medium roots; many, very fine, interstitial pores; neutral; abrupt, smooth boundary.

A12—4 to 15 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; massive; very hard, friable, sticky and plastic; few very fine and fine roots; many, very fine and common, fine, tubular pores; neutral; clear, wavy boundary.

B21—15 to 23 inches, mottled pale-brown (10YR 6/3), brown (10YR 5/3), and strong-brown (7.5YR 5/6) silt loam, olive brown (2.5Y 4/4), dark grayish brown (2.5Y 4/2), and very dark grayish brown (10YR 3/2) when moist; weak, fine, subangular blocky structure; hard, friable, slightly sticky and nonplastic; many very fine, fine, medium, and coarse roots; many, very fine and few, fine and medium, tubular pores; moderately alkaline; gradual, wavy boundary.

B22—23 to 27 inches, mottled pale-brown (10YR 6/3), dark-brown (10YR 3/3), and dark grayish-brown (10YR 4/2) heavy silt loam, dark yellowish brown (10YR 3/4), brown (10YR 5/3), and very dark grayish brown (10YR 3/2) when moist; weak, medium, platy structure; hard, friable, slightly sticky and nonplastic; common very fine, fine, medium, and coarse roots; many, very fine and few, fine, tubular pores; moderately alkaline; abrupt, wavy boundary.

IIC1—27 to 31 inches, brown (10YR 5/3) heavy loamy fine sand, very dark grayish brown (2.5Y 3/2) when moist; massive; slightly hard, very friable, nonsticky and nonplastic; many very fine, fine, medium, and coarse roots; common, very fine, tubular pores; moderately alkaline; abrupt, wavy boundary.

IIIC2ca—31 to 42 inches, mottled brown (10YR 5/3), grayish-brown (2.5Y 5/2), strong-brown (7.5YR 5/6), and reddish-brown (5YR 4/3) silty clay loam, very dark grayish brown (10YR 3/2) and brown (10YR 5/3) when moist; weak, coarse, subangular blocky structure parting to moderate, fine, subangular blocky; very hard, friable, sticky and plastic; common very fine, fine, medium, and coarse roots; common, very fine, tubular pores; moderately alkaline; strongly effervescent; disseminated lime; gradual, wavy boundary.

IIIC3ca—42 to 56 inches, mottled dark-brown (10YR 4/3), brown (10YR 5/3), and pale-brown (10YR 6/3) light silty clay loam, very dark grayish brown (10YR 3/2), dark grayish brown (2.5Y 4/2), and grayish brown (2.5Y 5/2) when moist; weak, coarse, subangular blocky structure parting to moderate, fine, subangular blocky; very hard, friable, sticky and plastic; few very fine, fine, medium, and coarse roots; many, very fine, tubular pores; moderately alkaline; strongly effervescent; disseminated lime; gradual, wavy boundary.

IIIC4ca—56 to 66 inches, mottled pale-brown (10YR 6/3), grayish-brown (10YR 5/2), brown (10YR 4/3), and reddish-brown (5YR 5/3) silty clay loam, very dark grayish brown (2.5Y 3/2), dark grayish brown (2.5Y 4/2), and grayish brown (2.5Y 5/2) when moist; weak, coarse, subangular blocky structure parting to moderate, fine, subangular blocky; very hard, friable, sticky and plastic; very few fine and very fine roots; common, very fine, tubular pores; moderately alkaline; strongly effervescent; disseminated lime.

The A horizon is grayish brown in hues of 10YR or 2.5Y. It is silty clay loam, clay loam, or silt loam.

The B horizon is commonly mottled in hues of 10YR and 2.5Y. Some prominent or distinct mottles in the hue of 7.5YR are also present in places. The B horizon is silt loam or silty clay loam. It is neutral to moderately alkaline and is calcareous in the lower part in places.

The C horizon is commonly stratified. It ranges from loamy fine sand to silty clay. The loamy sand is in the form of lenses from 1 to 4 inches thick.

Mottles that have chromas of 2 or less are above a depth of 20 inches.

So—Sycamore silty clay loam. This nearly level soil in on flood plains. It has the profile described as representative of the series.

Included with this soil in mapping are areas of Omni clay, along the lower part of the flood plain that make up about 3 percent of the mapping unit. Also included are areas of Sorrento silty clay on higher, better drained areas adjacent to channels of streams that make up 5 percent, areas of Laugenour loam that make up 4 percent, and areas of Delhi sand where channels of streams dissect old dunes that make up 2 percent. West of Pittsburg, a small area of soils that are slightly affected by salts is also included.

Runoff is slow, and the hazard of erosion is none to slight. The available water capacity is 9 to 11 inches. Roots can penetrate to a depth of more than 60 inches. The water table is a limitation in places where the soil is not drained.

This soil is used mainly for walnuts, apricots,

almonds, alfalfa, and field corn. Some areas are used for urban purposes. Capability unit I(17).

Sp—Sycamore silty clay loam, clay substratum. This nearly level soil is on flood plains. It has a profile similar to the one described as representative of the series, but it is underlain by clay at a depth of 40 to 60 inches.

Included with this soil in mapping are a few areas of soils that are 24 to 40 inches deep to clay. These areas make up about 5 percent of the mapping unit.

This soil has moderately slow permeability in the upper part and slow permeability in the layer of clay at a depth of 40 to 60 inches. Runoff is slow, and the hazard of erosion is slight. Roots can penetrate to a depth of 40 to 60 inches. The available water capacity is 6 to 11 inches.

This soil is used mainly for barley, but a few areas are used for apricot orchards. Capability unit IIw–2(17).

Tierra Series

The Tierra series consists of moderately well drained soils that formed in material weathered from sedimentary terrace deposits. These soils are on upland terraces. Slopes are 2 to 30 percent. Elevation ranges from 150 to 1,200 feet. The average annual air temperature is 59° F., and the frost-free season is 270 to 300 days. The average annual rainfall is 12 to 25 inches. These soils are dry from June to October and are moist from December to June in most years. The vegetation is annual grasses, forbs, and scattered oaks.

In a representative profile the surface layer is dark-gray and gray, strongly acid and medium acid loam and clay loam about 25 inches thick. The upper part of the subsoil is grayish-brown, medium acid to neutral clay about 34 inches thick. The lower part is light yellowish-brown, calcareous, silty clay loam that extends to a depth of more than 60 inches.

Permeability is slow, and the available water capacity is 3 to 6 inches. Roots can penetrate to a depth of 15 to 30 inches. Some water available to plants perches above the clay subsoil.

Tierra soils are used mainly for range and homesites. A few areas are used for walnuts.

Representative profile of Tierra loam, 2 to 9 percent slopes, about 700 feet southeast of Norris Canyon Road in the center of NE½NE¼NW¼ sec. 16, T. 2 S., R. 1 W.

Ap—0 to 4 inches, dark-gray (10YR 4/1) loam, very dark grayish brown (10YR 3/2) when moist; massive; hard, friable, slightly sticky and slightly plastic; many very fine roots; common, very fine, tubular and interstitial pores; strongly acid; clear, smooth boundary.

A12—4 to 13 inches, dark-gray (10YR 4/1) light clay loam, very dark gray (10YR 3/1) when moist; weak, coarse, prismatic structure; hard, friable, slightly sticky and slightly plastic; few very fine, fine, medium, and coarse roots; common, very fine and medium and few, fine, tubular pores; strongly acid; clear, smooth boundary.

A21—13 to 19 inches, dark-gray (10YR 4/1) and dark grayish-brown (10YR 4/2) clay loam, very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure; very hard, firm, slightly sticky and slightly plastic; few very fine, fine, medium, and coarse roots; common, very fine and few, fine and medium, tubular pores; strongly acid; clear, smooth boundary.

A22—19 to 25 inches, gray (10YR 5/1) clay loam, dark gray (10YR 4/1) when moist; moderate, medium, prismatic structure; very hard, firm, sticky and slightly plastic; few very fine, fine, medium, and coarse roots; common, very fine, tubular pores; medium acid; abrupt, wavy boundary.

B21t—25 to 42 inches, grayish-brown (2.5Y 5/2) clay, grayish brown (2.5Y 5/2) when moist; strong, coarse, prismatic structure; extremely hard, firm, sticky and very plastic; few slickensides; very few, very fine, exped roots; very few, very fine, tubular pores; thick continuous clay films on ped faces and lining pores; medium acid; gradual, smooth boundary.

B22t—42 to 59 inches, grayish-brown (2.5Y 5/2) clay, grayish brown (2.5Y 5/2) when moist; moderate, medium, angular blocky structure; extremely hard, friable, sticky and very plastic; no roots; common, very fine, tubular pores; continuous thin clay films on ped faces and lining pores; some iron and manganese concretions; neutral; clear, smooth boundary.

B3—59 to 71 inches, light yellowish-brown (2.5Y 6/4) silty clay loam, light olive brown (2.5Y 5/4) when moist; weak, medium, angular blocky structure; hard, friable, slightly sticky and slightly plastic; few, very fine, tubular pores; many thin clay films on ped faces and lining pores; moderately alkaline; highly calcareous; lime in seams.

The A horizon is 15 to 30 inches thick. It is dark gray, gray, grayish brown, brown, or dark yellowish brown. It has moist values of 2 or 3 in the upper part and 4 in the lower part. It is sandy loam, loam, or clay loam. The A11 or Ap horizon is typically massive and hard when dry.

The B2t horizon is grayish brown, brown, or yellowish brown. Its clay content is 45 to 55 percent.

The C horizon is silty clay loam or gravelly clay loam. It is calcareous in places.

TaC—Tierra loam, 2 to 9 percent slopes. This gently sloping to moderately sloping soil is on terraces. It has the profile described as representative of the series.

Included with this soil in mapping are areas of Positas loam on the lower margins of the terraces adjacent to and west of Ygnacio Valley that make up about 5 percent of the mapping unit. Also included are areas of Los Osos clay loam and areas of Botella clay loam along narrow drainageways. Each of these soils makes up 2 percent. Near Pinole Point about 800 acres of a soil that is very strongly acid sand and loamy sand in the upper part of the surface layer are also included.

Runoff is medium, and the hazard of erosion is moderate where the soil is bare.

This soil is used mainly for range and homesites. A few small areas are used for walnuts and small grain. Capability unit IVe–3(15); Claypan range site.

TaD—Tierra loam, 9 to 15 percent slopes. This strongly sloping soil is on upland terraces. Included with it in mapping are Los Osos clay loam and Millsholm loam, each of which makes up about 5 percent of the mapping unit.

Runoff is medium to rapid, and the hazard of erosion is moderate to high where the soil is bare.

This soil is used mainly for range and for urban

purposes. Capability unit IVe–3(15); Claypan range site.

TaE—Tierra loam, 15 to 30 percent slopes. This moderately steep soil is on upland terraces. Included with it in mapping are areas of Los Osos clay loam that make up about 5 percent of the mapping unit and areas of Millsholm loam that make up 7 percent. Also included is an area in the Briones hills that is as much as 30 percent Millsholm loam.

Runoff is medium to rapid, and the hazard of erosion is moderate to high where the soil is bare.

This soil is used mainly for range. Capability unit VIe–1(15); Claypan range site.

Urban Land

Ub—Urban land consists of areas that are filled with crushed rock or other material resistant to weathering. These areas are usually adjacent to the bay and are used for railroad yards and docks.

Also included in this mapping unit are upland areas that are covered by blacktop material to reduce the hazard of fire after severe grading and shaping for industrial structures. Not placed in a capability unit or range site.

Vallecitos Series

The Vallecitos series consists of well-drained soils that formed in material weathered from metasedimentary rock. These soils are on uplands. Slopes are 30 to 50 percent. Elevation ranges from 1,000 to 3,000 feet. The average annual air temperature is about 58° F., and the frost-free season is 240 to 290 days. The average annual rainfall is 16 to 24 inches. These soils are dry from June to October and are moist from December to June in most years. Vegetation is scattered oaks and digger pine and an understory of annual grasses and forbs.

In a representative profile the surface layer is brown, slightly acid loam in the upper 3 inches and reddish-brown, medium acid clay loam in the lower 7 inches. The subsoil is reddish-brown, medium acid light clay about 9 inches thick. Weathered shale is at a depth of 19 inches.

Permeability is slow, and the available water capacity is 2 to 4 inches. Roots can penetrate to a depth of 12 to 20 inches.

Vallecitos soils are used for range, recreation areas, and wildlife habitat.

Representative profile of Vallecitos loam, 30 to 50 percent slopes, along a road cut in the south quarter corner 1.1 miles southwest of Mount Diablo and 0.2 mile northwest of sec. 1, R. 1 W., T. 1 S.

A11—0 to 3 inches, brown (7.5YR 5/4) heavy loam, reddish brown (5YR 4/4) when moist; moderate, fine, granular structure; slightly hard, friable, sticky and slightly plastic; many very fine and common fine roots; many, very fine and fine, pores; slightly acid; clear, smooth boundary.

A12—3 to 10 inches, reddish-brown (5YR 5/4) clay loam, reddish brown (5YR 4/4) when moist; massive; hard, friable, sticky and plastic; many very fine and common fine roots; few, very fine, tubular pores; medium acid; clear, wavy boundary.

B21t—10 to 15 inches, reddish-brown (5YR 4/4) light clay, dark reddish brown (2.5YR 3/4) when moist; weak, medium, subangular blocky structure parting to weak, very fine, subangular blocky; very hard, firm, slightly sticky and very plastic; common very fine and few fine roots; few, very fine, tubular pores; many thin clay films in pores and on ped faces; medium acid; clear, smooth boundary.

B22t—15 to 19 inches, reddish-brown (5YR 4/4) light clay, yellowish red (5YR 4/6) when moist; weak, medium, subangular blocky structure parting to weak, very fine, subangular blocky; very hard, firm, sticky and very plastic; few very fine roots; very few, very fine, tubular pores; many thin clay films in pores and on ped faces; medium acid; discontinuous, wavy boundary.

R—19 to 40 inches, weathered shale; clay films along cleavages.

The A horizon is brown or reddish brown in hues of 7.5YR or 5YR and has moist values of 4. It is gravelly loam, loam, or clay loam and is medium acid to neutral.

The B2t horizon is reddish brown or yellowish red in hues of 2.5YR or 5YR. It is heavy clay loam or clay and is medium acid or slightly acid. The B2t horizon is absent in some places.

The R layer is hard (greater than 3 on Mohs scale) fractured shale or fine-grained sandstone that is metamorphic in places. Depth to weathered shale is 12 to 20 inches.

VaF—Vallecitos loam, 30 to 50 percent slopes. This steep soil is on uplands. Rock outcrops cover 4 to 8 percent of the surface. This is the only Vallecitos soil mapped in the county.

Included with this soil in mapping are areas of Gilroy clay loam that formed in intrusions of pillow basalt. These areas make up about 5 percent of the mapping unit. Areas of Dibble silty clay loam that formed from marginal soft sandstone and shale make up 2 percent. Also included are areas of soils as much as 40 inches deep to metasedimentary rock that are on extensive landslides where bedrock has been greatly fractured. These areas make up 8 percent of the mapping unit.

Runoff is rapid, and the hazard of erosion is high where the soil is bare.

This soil is used mainly for range, recreation areas, and wildlife habitat. Capability unit VIIe–1(15); Loamy range site.

Venice Series

The Venice series consists of very poorly drained soils in freshwater marshes on river deltas. Slopes are less than 1 percent. Elevation ranges from 5 to 15 feet below sea level. The mean soil temperature is about 60° F., and the frost-free season is 250 to 300 days. The average annual precipitation is 12 to 14 inches. Vegetation is reeds, rushes, bamboograss, blackberry, and willows.

In a representative profile the surface layer is black muck about 8 inches thick. Below this is variegated, very dark grayish-brown and dark yellowish-brown peat that extends to a depth of 60 inches.

Permeability is rapid, and the available water capacity is 8 to 16 inches. Roots can penetrate to a depth of 24 to 48 inches. The water table has been lowered to a depth of 2 to 4 feet by reclamation.

Venice soils are used for irrigated pasture, field corn, and recreation areas.

Representative profile of Venice muck, on Jersey Island in SW¼NE¼NE¼ sec. 5, T. 2 N., R. 3 E. (Color is for moist soil unless otherwise stated. pH is by 0.01M $CaCl_2$ method.)

Oap—0 to 8 inches, black (10YR 2/1) muck, very dark gray (10YR 3/1) when rubbed and dry; less than 5 percent fibers, none when rubbed; moderate, medium, granular structure; soft, slightly sticky and nonplastic; very strongly acid; clear, wavy boundary.

Oa1—8 to 25 inches, variegated very dark grayish-brown (10YR 3/2) and dark yellowish-brown (10YR 3/4 and 4/4) peat, very dark brown (10YR 2/2) when rubbed; massive; 65 percent fibers, 30 percent when rubbed; soft, slightly sticky and nonplastic; very strongly acid; diffuse, wavy boundary.

Oa2—25 to 60 inches, variegated very dark grayish-brown (10YR 3/2) and dark yellowish-brown (10YR 4/4) peat, very dark grayish brown (10YR 3/2) when rubbed; massive; 65 percent fibers, 40 percent when rubbed; nonsticky and nonplastic; very strongly acid.

The Oap horizon is 6 to 10 inches thick. Its content of unrubbed fibers is 0 to 5 percent.

The Oa horizon generally extends to a depth of more than 60 inches. It is very dark grayish brown, very dark brown, or dark brown. Its color by the sodium pyrophosphate test is 10YR 6/2 and 6/1. The Oa horizon ranges from medium acid to very strongly acid. The content of unrubbed fibers is 40 to 65 percent, and the content of rubbed fibers is 20 to 40 percent.

Layers that contain more than 65 percent fibers are present in places, but these layers total less than 10 inches in thickness. Layers that contain less than 5 percent fibers are also present in places, but these layers total less than 10 inches in thickness.

Vb—Venice muck. This level or nearly level soil is the only Venice soil mapped in the county. Included with it in mapping are areas of Rindge muck that make up about 8 percent of the mapping unit, areas of Webile muck that make up 4 percent, and areas of Egbert mucky clay loam that make up 3 percent.

Runoff is very slow, and there is no hazard of erosion while the soil is wet in winter. The hazard of soil blowing is moderate in summer. Some areas of this soil are susceptible to peat fires late in summer.

This soil is used for irrigated pasture, field corn, milo, asparagus, and tomatoes and for wildlife areas. Capability unit IIIw–10(16).

Webile Series

The Webile series consists of very poorly drained soils in fresh-water marshes and old river channels. Slopes are less than 1 percent. Elevation ranges from 5 to 15 feet below sea level. The average annual air temperature is about 60° F., and the mean annual soil temperature at a depth of 20 inches is 60°. The frost-free season is about 250 to 300 days. The average annual precipitation is 12 to 14 inches. If they are drained, these soils are dry to a depth of 3 to 5 feet in summer. Vegetation is willows, blackberries, rushes, and sedges.

In a representative profile the surface layer is black and very dark brown, very strongly acid muck about 16 inches thick. Below this is dark yellowish-brown, very strongly acid muck that extends to a depth of 43 inches. The substratum, to a depth of 48 inches, is very dark gray, slightly acid clay. Below this it is dark-gray, neutral silty clay to a depth of 63 inches.

Permeability is rapid in the upper part of the soil and slow in the underlying mineral layer. The available water capacity is 8 to 12 inches. The water table is lowered to a depth of 3 to 5 feet by open drains and pumping during the growing season. Roots can penetrate to a depth of 36 to 51 inches.

Webile soils are used for irrigated field corn, milo, asparagus, tomatoes, pasture, and small grain. Where field corn, milo, and tomatoes are grown, fields are flooded during winter for wildlife habitat.

Representative profile of Webile muck, on Byron Tract in SW¼NW¼SE¼ sec. 19, T. 1 N., R. 4 E. (projected). (Color is for moist soil. pH is by 0.01M $CaCl_2$ method.)

Oap1—0 to 9 inches, black (10YR 2/1) muck, black (10YR 2/1) when rubbed; no fibers are observable when unrubbed; very weak, very fine, granular structure; slightly hard, slightly sticky and nonplastic; very strongly acid; gradual, smooth boundary.

Oap2—9 to 16 inches, very dark brown (10YR 2/2) muck, very dark brown (10YR 2/2) when rubbed; less than 2 percent tule and reed fibers, none observable when rubbed; weak, very coarse blocky structure; slightly hard, slightly sticky and nonplastic; very strongly acid; clear, smooth boundary.

Oa3—16 to 28 inches, dark yellowish-brown (10YR 4/4) muck, very dark brown (10YR 2/2) when rubbed; 40 percent tule and reed fibers, less than 5 percent when rubbed; weak, thick, platy structure; slightly hard, slightly sticky and nonplastic; very strongly acid; gradual, smooth boundary.

Oa4—28 to 35 inches, dark yellowish-brown (10YR 3/4) muck, very dark brown (10YR 2/2) when rubbed; 40 percent tule and reed fibers, less than 10 percent when rubbed; weak, thick, platy structure; very friable, slightly sticky and nonplastic; very strongly acid; gradual, smooth boundary.

Oa5—35 to 38 inches, dark yellowish-brown (10YR 3/4) muck, very dark brown (10YR 2/2) when rubbed; 40 percent tule and reed fibers, less than 10 percent when rubbed; weak, thick, platy structure; very friable, slightly sticky and nonplastic; very strongly acid; gradual, smooth boundary.

Oa6—38 to 43 inches, dark yellowish-brown (10YR 4/4) muck, very dark brown (10YR 2/2) when rubbed; 20 percent tule and reed fibers, none observable when rubbed; weak, thick, platy structure; friable, slightly sticky and very slightly plastic; very strongly acid; clear, smooth boundary.

IIC1—43 to 48 inches, very dark gray (N 3/0) clay; about 10 percent yellow (2.5Y 7/6) fibers that darken when exposed to air; massive; firm, very sticky and plastic; slightly acid; gradual, smooth boundary.

IIC2—48 to 63 inches, dark-gray (N 4/0) silty clay; massive; firm, very sticky and plastic; neutral.

The Oa horizon is 36 to 51 inches thick. It contains 45 to 70 percent ash to a depth of 36 to 48 inches. Lenses of moderately decomposed material are below a depth of 17 inches in some places, but they total less than 10 inches in thickness. Thin lenses of gray (10YR 5/1) mineral material are below a depth of 28 inches in places. The soils shrink and crack between depths of 9 and 28 inches.

The Oa2 layer contains as much as 10 percent fibers unrubbed and less than 2 percent when rubbed. The Oa3 layer contains 35 to 60 percent fibers unrubbed and less than 5 percent when rubbed. It contains about 25 to 40 percent organic matter. Reaction of undried samples from

layers above the IIC1 horizon ranges from pH of 4.5 to 6.0 in 0.01 M calcium chloride.

The IIC horizon is very dark gray, dark gray, or dark greenish gray and is clay, silty clay, sandy clay, or heavy silty clay loam. It is slightly acid to mildly alkaline.

Wa—Webile muck. This is the only Webile soil mapped in the county. Included with it in mapping are areas of Kingile muck that make up about 10 percent of the mapping unit and areas of Egbert mucky clay loam that make up 5 percent.

Runoff is very slow, and the hazard of soil blowing is moderate where the soil is tilled and exposed.

This soil is used for irrigated field corn, milo, asparagus, tomatoes, pasture, and small grain. Capability unit IIIw–10(16).

Zamora Series

The Zamora series consists of well-drained soils that formed in alluvium from sedimentary rock. These soils are on alluvial fans and low terraces. Slopes are 0 to 5 percent. Elevation ranges from 100 to 500 feet. The average annual air temperature is 59° F., and the frost-free season is 260 to 330 days. The average annual rainfall is 14 to 24 inches. These soils are dry from June to October and are moist to a depth of 16 inches from late in December to June in most years. Vegetation is annual grasses, forbs, and scattered oaks.

In a representative profile the surface layer is grayish-brown and dark grayish-brown, slightly acid light silty clay loam about 16 inches thick. The subsoil is dark grayish-brown, slightly acid silty clay loam to a depth of 28 inches and brown, neutral and moderately alkaline silty clay loam to a depth of 60 inches. The substratum is grayish-brown, moderately alkaline light clay loam to a depth of 72 inches.

Permeability is moderately slow, and the available water capacity is 10 to 12 inches. Roots can penetrate to a depth of more than 60 inches.

Most areas of Zamora soils are used for homesites. A few small areas are used for irrigated walnut orchards, row crops, and pasture and for dryland pasture and hay.

Representative profile of Zamora silty clay loam, 0 to 2 percent slopes, 1,800 feet west of Oak Grove Road and 350 feet north of Walnut Avenue.

Ap—0 to 4 inches, grayish-brown (10YR 5/2) light silty clay loam, very dark grayish brown (10YR 3/2) when moist; massive; very hard, friable, sticky and plastic; many very fine roots; many, very fine and fine, tubular pores; slightly acid; clear, smooth boundary.

A12—4 to 16 inches, dark grayish-brown (10YR 4/2) light silty clay loam, very dark grayish brown (10YR 3/2) when moist; massive; very hard, friable, sticky and plastic; few very fine and common fine and medium roots; many, very fine, tubular pores; slightly acid; gradual, wavy boundary.

B1t—16 to 28 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, angular blocky structure; very hard, friable, sticky and plastic; few very fine, fine, and medium roots; common fine and very fine pores; few thin clay films lining pores; slightly acid; gradual, wavy boundary.

B2t—28 to 46 inches, brown (10YR 4/3) silty clay loam, dark brown (10YR 3/3) when moist; weak, fine, angular blocky structure; very hard, friable, sticky and plastic; few very fine and fine roots; common, fine, tubular pores; few thin clay films on ped faces and lining pores; neutral; gradual, wavy boundary.

B3—46 to 60 inches, brown (10YR 4/3) light silty clay loam, dark brown (10YR 3/3) when moist; weak, fine, angular blocky structure; very hard, friable, sticky and plastic; few very fine roots; common fine pores; few thin clay films lining pores and on ped faces; moderately alkaline; gradual, wavy boundary.

C—60 to 72 inches, grayish-brown (10YR 5/2) light clay loam, dark brown (10YR 3/3) when moist; very hard, friable, sticky and plastic; very few very fine roots; common, very fine and few, fine, tubular pores; few thin clay films lining pores; massive; moderately alkaline.

The solum is 35 to 60 inches thick. The A horizon is dark grayish brown, grayish brown, or dark brown in hues of 7.5YR and 10YR and has moist values and chromas of 2 or 3. It is silty clay loam or clay loam. The A horizon is typically massive and very hard when dry. It is slightly acid or neutral.

The B horizon is dark grayish brown, grayish brown, or brown in hues of 10YR. It is heavy silt loam, clay loam, or silty clay loam.

The C horizon is grayish brown, brown, or yellowish brown in hues of 10YR and is clay loam or gravelly clay loam. It is mildly alkaline or moderately alkaline.

ZaA—Zamora silty clay loam, 0 to 2 percent slopes. This nearly level soil is on alluvial fans and terraces. It has the profile described as representative of the series.

Included with this soil in mapping are areas of Garretson loam adjacent to small drainageways, small areas of Los Robles clay that formed in alluvium from basic igneous rock, and areas of Rincon clay loam. Each of these soils makes up about 5 percent of the mapping unit. Also included are a few areas of very deep soils that consist of gravelly clay loam and very gravelly clay loam and an area of soil near Antioch that has a surface layer that is predominantly loam or silt loam.

Runoff is slow, and there is no hazard of erosion.

Most areas of this soil are used for homesites and related uses. A few areas are used for irrigated walnut orchards, row crops, and pasture and for dryland pasture and hay. Capability unit I(17).

ZaB—Zamora silty clay loam, 2 to 5 percent slopes. This gently sloping soil is on alluvial fans, low terraces, and floors of small upland valleys. Included with it in mapping are areas of Garretson loam adjacent to small drainageways, areas of Los Robles clay loam on small alluvial fans that formed from basic igneous rock, and areas of Rincon clay loam. Each of these soils makes up about 5 percent of the mapping unit. Also included are a few areas in small upland valleys where slopes are 5 to 9 percent.

Runoff is slow, and the hazard of erosion is slight.

Most areas of this soil are used for homesites and for dryland volunteer hay and grain. Capability unit IIe–1(17).

Use and Management of the Soils

This section includes an explanation of the system of capability classification commonly used by the Soil

Conservation Service and of modifications based on climatic differences of the three land resource areas in the county. The capability units in the county are described, and suggestions are made for managing the soils in these units. Following this, predicted yields are given for the principal crops grown in the county, as well as the management required to obtain those yields. Then the Storie Index ratings are explained. Management of the soils by range sites is discussed. The soils are rated according to their suitability for wildlife habitat. In the last part of this section, properties of the soils important in engineering and interpretations for various engineering uses are given, mainly in tables.

Capability Grouping

Capability grouping shows, in a general way, the suitability of soils for most field crops. The soils are grouped according to their limitations if used for field crops, the risk of damage if they are so used, and the way they respond to management. The grouping does not take into account major and general expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range or engineering uses.

In the capability system, the soils are grouped at three levels: the capability class, subclass, and unit. These are discussed in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have some limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife habitat. (None in Contra Costa County)

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture, range, woodland, or wildlife habitat.

Class VII soils have very severe limitations that make them unsuited to cultivation and restrict their use largely to pasture, range, woodland, or wildlife habitat.

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife habitat, or water supply or to esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class. They are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral (for example, IIe). The letter *e* shows that the main limitation is risk of erosion; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, saline, or stony; and c, used only in some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In capability class I there are no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in this class are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife habitat, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils.

Capability units in classes I through IV in California are given Arabic numerals to indicate the chief kind of limitation responsible for placement of a soil in a given capability class and subclass. For this reason, some of the units in the subclasses are not numbered consecutively, and their symbols are a partial indication of soil features. Soils in classes V through VIII are given the nonconnotative Arabic numeral 1. In California the numerals used to designate units within the classes and subclasses are these:

0. A limitation caused by coarse sandy material in the substratum.
1. An erosion hazard, actual or potential.
2. A wetness limitation caused by poor drainage or flooding.
3. A limitation of slow permeability or very slow permeability in the subsoil.
4. A limitation caused by coarse soil texture.
5. A limitation caused by fine soil texture.
6. A limitation caused by salt or alkali.
7. A limitation caused by stones or cobbles.
8. A limitation caused by shallow depth of the soil to bedrock.
9. A limitation caused by low fertility.
10. A limitation caused by high organic-matter content.

Land resource areas

Contra Costa County falls into three land resource areas that differ in climate, topography, vegetation, and land use. In a nation-wide classification system, these areas are designated 15, 16, and 17 (*5*). Land resource area 15 is the Central California Coast Range, part of which is in the western and central parts of Contra Costa County. Land resource area 16 is the California Delta, part of which is along the eastern side of Contra Costa County. Land resource area 17 is the San Joaquin Valley, in the eastern part of the county, and some intermountain coastal valleys.

Soils in these resource areas may be similar and have the same capability unit symbol, but management needs will differ because of the differences in climate, vegetation, and kind of crops that can be grown. Because of these variations, each capability unit symbol is followed by the number 15, 16, or 17 in parentheses to identify its resource area. For example, capability units VIw–1(16) and VIw–1(17) both include soils that have a high water table. Unit VIw–1(16) is in the California Delta resource area, and unit VIw–1(17) is in the San Joaquin Valley resource area.

The following paragraphs describe the land resource areas in Contra Costa County.

CENTRAL CALIFORNIA COAST RANGE, LAND RESOURCE AREA 15

This resource area includes the mountainous uplands and dissected terraces in the eastern and central parts of the county. The soils in these areas are gently sloping to extremely steep. Elevation ranges from 10 to 3,849 feet. Annual rainfall is 12 to 30 inches; less than an inch falls in summer. The frost-free season is 250 to 300 days. The less sloping soils are used mainly for dryland grain and pasture. The steeper soils are used for range, wildlife habitat, and recreation.

The actual evapotranspiration for a soil in this area is 10 to 12 inches (*3*, *4*). Irrigation water generally is not available. Irrigated soils in this area are treated as outlying sections of Resource Area 17.

CALIFORNIA DELTA, LAND RESOURCE AREA 16

This resource area includes the delta along the eastern part of the county and the tidal area adjacent to San Pablo and Suisun Bays. The soils are predominantly organic, but some are mineral soils that have a high organic-matter content. The soils are nearly level. Elevation ranges from 15 feet below sea level to 25 feet above sea level. Annual rainfall is 14 to 22 inches; less than an inch falls in summer. The frost-free season is 250 to 310 days.

Most of this area is protected by levees. The water table is lowered by a system of open drains and by pumping. Most of the soils are intensively cultivated. In winter many areas are flooded to control weeds, firm up the surface layer for the seedbed, and reduce salts. These flooded areas are used for wildlife habitat.

SACRAMENTO-SAN JOAQUIN VALLEYS, LAND RESOURCE AREA 17

This resource area includes the valley part of the county. Most of the soils are nearly level. Elevation ranges from sea level to 500 feet above sea level. Annual rainfall is 12 to 25 inches; less than an inch falls in summer. The frost-free season is 250 to 310 days. Most of this area is irrigated for intensive cultivation. The rest is used for dry-farmed grain or pasture.

The capability classification for this resource area is based primarily on the criteria for irrigated land.

Saline or alkali conditions or both can be improved or reduced in most soils, but not completely eliminated.

Management by capability units

In the following pages the capability units in Contra Costa County are described, and suggestions for use and management are given. The capability unit for each soil in the county is listed in the "Guide to Mapping Units" at the back of this survey.

For all tillable soils, a suitable conservation cropping system should include legumes or crops or both that produce a large amount of residue. Returning crop residue to the soil helps improve soil tilth and rate of water intake. Minimum tillage reduces soil compaction. All crops except legumes respond to applications of nitrogen fertilizer. Fertilizer should be applied as indicated by soil or plant tissue tests. Controlling pests and diseases is necessary to protect crops.

In orchards and vineyards, soil tilth and water intake can be improved and maintained by growing cover crops or green manure crops, by mulching, or by using a program for weed control that does not include tillage.

In areas used for pasture or range, proper grazing management is needed. Range areas should also be protected from fires.

CAPABILITY UNIT I(17)

This unit consists of well drained and moderately well drained soils in the Botella (fig. 7), Brentwood, Conejo, Garretson, Los Robles, Sorrento, Sycamore, and Zamora series and poorly drained soils in the Sycamore series. These soils are very deep and have slopes of 0 to 2 percent. They formed on alluvial fans and flood plains. They have a surface layer and subsoil of loam, clay loam, and silty clay loam.

Permeability is moderate or moderately slow in the subsoil. The available water capacity is 9 to 12 inches. Roots can penetrate to a depth of more than 60 inches. Runoff is very slow to slow, and there is little or no hazard of erosion. The average annual rainfall is 12 to 25 inches, and the frost-free season is 250 to 330 days.

Natural stream cutting and reclamation have lowered the water table of the Sycamore soils to a depth of more than 60 inches.

These soils are suited to most crops grown in the county, such as walnuts, alfalfa, apricots, tomatoes, head lettuce, sugar beets, and almonds. Tomatoes and head lettuce are commonly double cropped with barley.

The soils can be irrigated by furrows, borders, or sprinklers. Irrigation water should be applied only as needed by crops to reduce the loss of water and leach-

Figure 7.—**Typical landscape of Botella and Conejo soils in the foreground and Altamont and Diablo soils in the background.**

ing of nutrients. Land leveling or shaping can be done with little difficulty.

CAPABILITY UNIT IIe–1(17)

This unit consists of well-drained soils in the Botella, Conejo, Garretson, and Zamora series. These soils are very deep and have slopes of 2 to 9 percent. They formed on alluvial fans and low terraces. They have a surface layer and subsoil of loam, clay loam, and silty clay loam.

Permeability is moderate or moderately slow in the subsoil. The available water capacity is 9 to 12 inches. Roots can penetrate to a depth of more than 60 inches. Runoff is slow, and the hazard of erosion is slight where the soils are tilled and exposed. The average annual rainfall is 12 to 25 inches, and the frost-free season is 250 to 330 days.

These soils are used mainly for dryland walnuts, volunteer hay, and dryland pasture and for recreation areas and homesites. They are suited to most crops grown in the county.

The soils can be irrigated by sprinklers or contour furrows. Cultivation should be across slopes to reduce the hazard of erosion.

CAPABILITY UNIT IIe–3(17)

Rincon clay loam, 2 to 9 percent slopes, and Rincon clay loam, 9 to 15 percent slopes, are the only soils in this capability unit. These soils formed on valley fill and benches in alluvium from sedimentary rock. They have a surface layer of clay loam and a subsoil of clay. Permeability is slow, and the available water capacity is 8 to 10 inches. Roots can penetrate to a depth of more than 60 inches. The average annual rainfall is 12 to 16 inches, and the frost-free season is 260 to 300 days.

Rincon clay loam, 2 to 9 percent slopes, is the more extensive soil in this unit. Runoff is medium, and the hazard of erosion is slight where the soil is tilled and exposed. This soil is suited to dryfarmed grain, forage crops, row crops, and orchards and to irrigated pasture. It is used mainly for dryfarmed barley.

All residue from dryfarmed grain should be returned to the soil to help reduce runoff and control erosion. The soil can be irrigated by sprinklers or contour furrows. Irrigation water should be applied to help conserve water and control erosion. Land leveling is needed for surface irrigation. Deep cuts that expose the subsoil should be avoided. Because of the slow permeability of the subsoil, care should be taken to prevent the formation of a perched water table. Outlets and waterways should be controlled to help prevent gullying.

Rincon clay loam, 9 to 15 percent slopes, is used mainly for homesites and related urban uses and for range. Runoff is medium to rapid, and the hazard of erosion is moderate to severe where the soil is tilled and exposed.

CAPABILITY UNIT IIe5–(17)

This unit consists of moderately well drained clay soils in the Capay and Cropley series. These soils are very deep and have slopes of 2 to 9 percent. They formed on fans and benches from sedimentary rock.

Permeability is slow, and the available water capacity is 8 to 10 inches. Roots can penetrate to a depth of more than 60 inches. Runoff is slow, and the hazard of erosion is slight where the soils are tilled and exposed. The average annual rainfall is 14 to 20 inches, and the frost-free season is 250 to 300 days.

These soils are suited to irrigated pasture, alfalfa, small grain, and some orchard crops. They are used mainly for dryfarmed barley, volunteer hay, and homesites.

The soils can be irrigated by sprinklers or contour furrows. The application rate for irrigation water should not exceed 0.15 inches per hour. The soils should be tilled only when moist. If they are worked when too dry, they form large, hard clods, and if worked when too wet, they puddle and seal over.

CAPABILITY UNIT IIw–2(17)

This unit consists of soils in the Brentwood, Omni, Rincon, and Sycamore series. These soils have slopes of 0 to 2 percent. They formed on flood plains and low terraces. They have a subsoil of clay loam, silty clay loam, and clay. Brentwood clay loam, wet, is the most extensive soil in this unit.

Permeability is moderately slow and slow, and the available water capacity is 4 to 11 inches. The soils have a perched water table between depths of 40 and 50 inches. Roots can penetrate to a depth of 40 to more than 60 inches. Runoff is slow or very slow, and the soils are ponded in places. There is no hazard of erosion where the soils are tilled and exposed. The average annual rainfall is 12 to 16 inches, and the frost-free season is 250 to 300 days.

These soils are suited to row crops, field crops, and alfalfa. They are suited to some orchard crops if interceptor tile drains are installed and maintained. They are used mainly for tomatoes, sugar beets, head lettuce, and alfalfa. Tomatoes and head lettuce are commonly double cropped with barley.

Excess surface water should be removed, and the soils should be irrigated in a way that controls the water table.

CAPABILITY UNIT IIw–5(17)

Capay clay, wet, 0 to 2 percent slopes, is the only soil in this capability unit. It formed on valley fill. It has a clay subsoil and a substratum of silty clay loam or clay.

Permeability is slow, and the available water capacity is 6 to 8 inches. The depth to which roots can penetrate is limited to 40 to 50 inches by the water table. Runoff is very slow, and there is no hazard of erosion where the soil is tilled and exposed. The average annual rainfall is 14 to 16 inches, and the frost-free season is 250 to 300 days.

This soil is suited to row crops and forage crops. It is used mainly for tomatoes, head lettuce, sugar beets, apricots, alfalfa, walnuts, almonds, and irrigated pasture. Tomatoes and head lettuce are commonly double cropped with barley.

Good management of irrigation water is necessary to reduce waterlogging and to avoid raising the water table. Drainage, such as by interceptor tile drains, is needed for long-lived, deep-rooted crops. If this soil is tilled when too dry, it forms large clods, and if tilled when too wet, it is likely to seal over.

CAPABILITY UNIT IIs–6(17)

Sorrento silty clay loam, sand substratum, and Laugenour loam are the only soils in this capability unit. These soils have slopes of 0 to 2 percent. They are on flood plains.

The Sorrento soil is well drained; artificial drainage has lowered the water table of the Laugenour soil to a depth of 60 inches in most places. Permeability is moderate and moderately slow in the upper part of the soils and rapid in the substratum. The available water capacity is 5 to 9 inches. Roots can penetrate to a depth of more than 60 inches. The average annual rainfall is 14 to 18 inches, and the frost-free season is 250 to 300 days.

These soils are suited to most crops grown in the county. They are used mainly for almonds and apricots.

Irrigation water should be applied frequently and only in amounts needed by crops to reduce the loss of water and leaching of nutrients. Deep cuts that expose the sand substratum should be avoided.

CAPABILITY UNIT IIs–3(17)

This unit consists of well drained and moderately well drained soils in the Rincon and Conejo series. These soils are very deep and have slopes of 0 to 2 percent. They formed on low terraces and flood plains. They have a surface layer of clay loam and a subsoil or substratum of clay.

Permeability is slow, and the available water capacity is 7 to 10 inches. Roots can penetrate to a depth of more than 60 inches, although the clay subsoil or substratum restricts the movement of roots and water somewhat. Runoff is slow, and the hazard of erosion is slight where the soils are tilled and exposed. The average annual rainfall is 12 to 25 inches, and the frost-free season is 260 to 300 days.

These soils are suited to row crops, field crops, alfalfa, irrigated pasture, and some orchard crops. They are used mainly for almonds, apricots, tomatoes, sugar beets, alfalfa, and head lettuce. Tomatoes and head lettuce are commonly double cropped with barley.

Irrigation water should be applied in a way that controls waterlogging and prevents formation of a perched water table. Deep cuts that expose the subsoil and substratum should be avoided.

CAPABILITY UNIT IIs–5(17)

Capay clay, 0 to 2 percent slopes, and Clear Lake clay are the only soils in this capability unit. Capay clay is moderately well drained, and Clear Lake clay is poorly drained. On Clear Lake clay the natural drainage has been altered by stream cutting, and the water table has been lowered to a depth of 60 inches or more. Permeability is slow, and the available water capacity is 8 to 10 inches. Roots can penetrate to a depth of 60 inches. Runoff is very slow to slow, and there is no hazard of erosion where the soils are tilled

and exposed. The average annual rainfall is 14 to 25 inches, and the frost-free season is 250 to 300 days.

These soils are suited to row crops, field crops, dryfarmed grain, and some orchard crops. They are used mainly for apricots, almonds, tomatoes, head lettuce, alfalfa, and sugar beets. Tomatoes and head lettuce are commonly double cropped with barley.

Excess surface water should be drained. Land leveling is necessary in places for management of irrigation water. Irrigation water should be applied infrequently and slowly over long periods because of the slow permeability. If the soils are worked when too dry, they form large clods, and if worked when too wet, they puddle and seal over.

CAPABILITY UNIT IIIe-3(15)

Perkins gravelly loam, 2 to 9 percent slopes, is the only soil in this capability unit. It formed on old terraces. It has a subsoil of gravelly clay loam.

Permeability is slow in the subsoil. The available water capacity is 5 to 7 inches. Roots can penetrate to a depth of 36 to 50 inches. Runoff is slow to medium, and the hazard of erosion is slight to moderate where the soil is tilled and exposed. The average annual rainfall is 14 to 18 inches, and the frost-free season is 260 to 300 days.

This soil is suited to vineyards, grain, and pasture. It is used mainly for pasture and homesites.

This soil can be cultivated one year out of three. It should be cultivated across the slope to reduce runoff and erosion. Vineyards should be planted across the slope or on the contour. Cover crops grown in winter and spring can help control erosion. Waterways should not be cultivated and should be seeded, if necessary, to maintain vegetative cover.

CAPABILITY UNIT IIIe-5(15)

Most of the acreage in this unit consists of well-drained soils in the Altamont and Diablo series. These soils are deep and have slopes of 9 to 15 percent. They formed on nplands. They have a surface layer and subsurface layer of clay.

Permeability is slow, and the available water capacity is 6 to 8 inches. Roots can penetrate to a depth of 40 to 60 inches. Runoff is slow to medium, and the hazard of erosion is slight to moderate where the soils are tilled and exposed. The average annual rainfall is 12 to 20 inches, and the frost-free season is 260 to 300 days.

Also in this unit are areas of Linne clay loam, 5 to 15 percent slopes. It is clay loam underlain by shale and sandstone. Permeability is moderately slow. Roots can penetrate to a depth of 20 to 40 inches.

These soils are suited to dryfarmed grain, pasture, and hay. They are used mainly for barley and hay.

The soils can be cultivated one year out of three. The clay texture causes limitations in the use and management of the Altamont and Diablo soils. If these soils are tilled when too dry, they form large clods, and if tilled when too wet, they puddle and seal over. Waterways should not be cultivated and should be seeded, if necessary, to maintain vegetative cover.

CAPABILITY UNIT IIIw-2(16)

This unit consists of poorly drained and very poorly drained soils in the Egbert, Merritt, and Ryde series. These soils have slopes of less than 2 percent. They formed in old river channels and levees on the delta. Merritt and Ryde soils have a surface layer of loam and silt loam underlain by a layer of silt loam. Egbert soil has a surface layer of mucky clay loam and a subsoil of slowly permeable clay.

Permeability is moderate, and the available water capacity is 6 to 8 inches. Roots can penetrate to a depth of 40 to 60 inches. Runoff is very slow, and there is no hazard of erosion. The average annual rainfall is 12 to 16 inches, and the growing season is 260 to 300 days.

These soils are suited to corn, milo, asparagus, tomatoes, and irrigated pasture. They are used mainly for corn and asparagus.

The soils are drained by a system of open drains and pumping. The water table is lowered to a depth of 40 to 60 inches during the growing season, but it can be within a foot of the surface in winter. The soils should be irrigated in a way that prevents accumulation of salts and keeps the water table from rising.

CAPABILITY UNIT IIIw-8(16)

Sacramento clay is the only soil in this capability unit. This soil is poorly drained and has slopes of less than 2 percent. It formed on rims of basins adjacent to the delta.

Permeability is slow in the clay subsoil. The available water capacity is 7 to 9 inches. The depth to which roots can penetrate is limited to 48 to 60 inches by the water table. Runoff is slow, and the soil is ponded in some places. There is no hazard of erosion where the soil is tilled and exposed. The average annual rainfall is 12 to 16 inches, and the frost-free season is 260 to 300 days.

This soil is suited to field corn, sugar beets, tomatoes, asparagus, safflower, irrigated pasture, and dryfarmed grain. It is used mainly for sugar beets, field corn, and tomatoes.

Drainage is necessary to remove excess water and maintain the rooting depth for crops. The soil should be irrigated in a way that controls waterlogging and keeps the water table from rising. If this soil is tilled when too dry, it forms large clods, and if tilled when too wet, it is likely to seal over.

CAPABILITY UNIT IIIw-10(16)

This unit consists of mainly very poorly drained soils in the Kingile, Rindge, Shima, Venice, and Webile series. These soils have slopes of less than 2 percent. They formed on the delta. They have a surface layer of muck underlain by muck or peat to a depth of 16 to more than 60 inches. The underlying mineral material is clayey except in Shima soils where it is sand.

Permeability is rapid, and the available water capacity is 6 to 16 inches. Runoff is very slow. The hazard of soil blowing is moderate where the soils are tilled and exposed. The average annual rainfall is 12

to 16 inches, and the frost-free season is 250 to 310 days.

These soils are suited to field corn, milo, asparagus, irrigated pasture, and tomatoes and to wildlife habitat. They are used mainly for field corn, asparagus, and irrigated pasture.

The soils are drained by a system of open drains and pumping. The water table is lowered to a depth of 2 to 5 feet during the growing season. To reduce subsidence (fig. 8) caused by oxidation, the water table should not be lowered beyond the depth needed for crop roots. Areas used for corn, milo, and tomatoes should be flooded after the harvest to control weeds, to make a firmer seedbed for spring planting, and to leach some salts. Flooded areas also make excellent habitat for waterfowl. The soils should be irrigated by spud ditches or by subirrigation. A ratio of about 2:1 of cut over fill should be used in land leveling or shaping for irrigation.

CAPABILITY UNIT IIIs–3(17)

This unit consists of moderately well drained soils in the Antioch, Positas, and San Ysidro series. These soils have slopes of 0 to 2 percent. They formed on old terraces. They have a surface layer of loam and a subsoil of clay.

Permeability is very slow in the subsoil. The available water capacity is 3.5 to 5 inches. Roots can penetrate to a depth of 10 to 24 inches. Runoff is slow, and the hazard of erosion is slight where the soils are tilled and exposed. The average annual rainfall is 10 to 18 inches, and the frost-free season is 260 to 300 days.

These soils are suited to irrigated pasture, dry-farmed grain, and dryland pasture. They are used mainly for dryland pasture, but a few areas are used for irrigated pasture.

The soils should be irrigated in a way that prevents waterlogging and prevents the formation of a perched water table over the clay subsoil. Deep cuts that decrease the depth to which roots can readily penetrate or that expose the clay subsoil should be avoided.

CAPABILITY UNIT IIIs–4(17)

Delhi sand, 2 to 9 percent slopes, and Briones fine sandy loam, 2 to 5 percent slopes, are the only soils in this capability unit. Delhi sand is the more extensive soil in this unit. This soil is somewhat excessively drained, very deep sand. It formed in wind-modified deposits of mixed origin.

Permeability is rapid, and the available water capacity is about 3.75 inches. Roots can penetrate to a depth of more than 60 inches. Runoff is slow or very slow, and the hazards of soil blowing and water erosion are slight where the soil is tilled and exposed. The average annual rainfall is 12 to 14 inches, and the frost-free season is 260 to 300 days.

Delhi sand is suited to almonds and grapes. It is used mainly for almonds, but a few areas are used for walnuts.

This soil should be irrigated by sprinklers, and application should be light and frequent. Cover crops

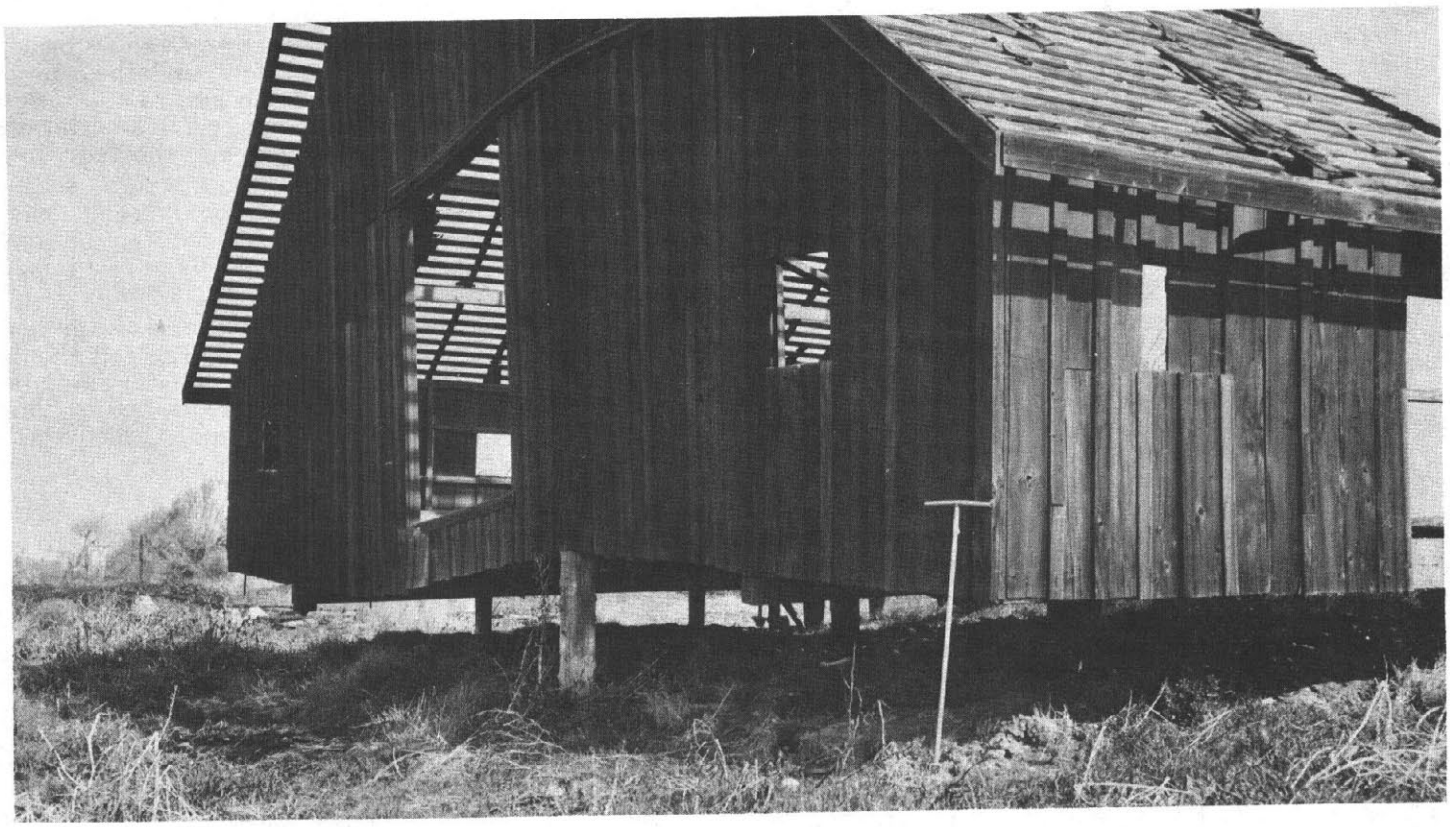

Figure 8.—**Damage caused by subsidence on the Rindge soils.**

should be planted and mowed by a rotary mower during the growing season to control soil blowing.

Briones fine sandy loam, 2 to 5 percent slopes, is moderately deep over a weakly cemented layer. Permeability is moderately rapid in the upper part and moderately slow in the weakly cemented layer. The available water capacity is 3.5 to 5 inches. Roots can penetrate to a depth of 30 to 40 inches. This soil is used mainly for homesites. A few areas are used for dryland walnuts.

CAPABILITY UNIT IVe–1 (15)

This unit consists of well-drained soils in the Gilroy, Linne, and Los Gatos series. These soils have slopes of 15 to 30 percent. They formed on foothills and uplands. They have a surface layer of loam and clay loam and a subsoil of clay loam.

Permeability is moderately slow in the subsoil. The available water capacity is 4 to 8 inches. Roots can penetrate to a depth of 20 to 40 inches. Runoff is medium, and the hazard of erosion is moderate where the soils are bare. The average annual rainfall is 12 to 25 inches, and the frost-free season is 260 to 300 days.

These soils are suited to dryfarmed grain, volunteer hay, and range. They are used mainly for range.

The soils should be cultivated no more than one year out of five to control erosion. Cultivating across the slope helps control erosion and conserve water. Waterways should not be cultivated and should be seeded, if necessary, to maintain vegetative cover.

CAPABILITY UNIT IVe–3 (15)

This unit consists of moderately well drained and well drained soils in the Antioch, Dibble, Kimball, Los Osos, Perkins, Positas, and Tierra series. These soils have slopes of 2 to 30 percent. They formed on terraces and uplands. They have a surface layer of gravelly loam, loam, silty clay loam, and clay loam and a subsoil of clay loam, gravelly clay loam, silty clay, and clay.

Permeability is slow to very slow in the subsoil. The available water capacity is 3.5 to 6 inches. Roots can penetrate to a depth of 10 to 50 inches. Runoff is slow to rapid, and the hazard of erosion is slight to high. The average annual rainfall is 12 to 25 inches, and the frost-free season is 260 to 300 days.

These soils are suited to dryfarmed grain, volunteer hay, and range. Where irrigation water is available, they are suited to irrigated pasture. They are used mainly for range.

The soils should be cultivated no more than one year out of five to control erosion. Cultivation should be across the slope or on the contour. These soils can be irrigated by sprinklers.

CAPABILITY UNIT IVe–5 (15)

Most of the acreage in this unit consists of well-drained soils in the Alo, Altamont, Diablo, and Sehorn series. These soils have slopes of 15 to 30 percent. They formed on uplands. They have a surface layer and subsurface layer of clay. Permeability is slow, and the available water capacity is 3.5 to 9 inches. Roots can penetrate to a depth of 25 to 60 inches. Runoff is medium, and the hazard of erosion is moderate where the soils are bare. The average annual rainfall is 12 to 25 inches, and the frost-free season is 260 to 300 days.

Also in this unit are soils of the Fontana-Altamont complex. The Fontana soil is silty clay loam 20 to 36 inches deep to sandstone. It has moderately slow permeability. As much as 5 percent of the Fontana-Altamont complex consists of rock outcrops, making tillage somewhat difficult.

These soils are suited to dryfarmed grain, volunteer hay, and range. They are used mainly for barley and range.

The soils should be cultivated no more than one year out of four to control erosion. Cultivation should be across the slope or on the contour. Waterways should not be cultivated and should be seeded, if necessary, to maintain a vegetative cover. If tilled when too dry, the clayey soils form large clods, and if tilled when too wet, they puddle and seal over.

CAPABILITY UNIT IVe–9 (16)

Piper fine sandy loam is the only soil in this capability unit. This poorly drained soil formed on low mounds and ridges on the delta. It has slopes of 2 to 5 percent.

Permeability is slow in the subsoil. The available water capacity is 3 to 5 inches. Roots can penetrate to a depth of 20 to 36 inches. Runoff is slow to medium, and the hazard of soil blowing is moderate where the soil is tilled and exposed. The average annual rainfall is 12 to 16 inches, and the frost-free season is 250 to 300 days.

This soil is suited to irrigated pasture and to dryfarmed grain and pasture. It is used mainly for dryfarmed grain and pasture.

Sprinkler irrigation is the best method on these soils. Applications of water should be frequent and light to prevent the leaching of nutrients and raising the water table. Cuts as much as 6 feet deep may be needed to level the surface for irrigation. If the land is leveled, the surface soil should be stockpiled and manure added to the cut areas.

CAPABILITY UNIT IVw–4 (16)

Piper loamy sand and Piper sand are the soils in this capability unit. These soils are very poorly drained and are sandy to a depth of 60 inches. They have slopes of less than 2 percent. They formed on old dunes on the delta that have been cut and filled during land leveling for irrigation.

Permeability is moderate to rapid, and the available water capacity is 3 to 4 inches. Roots can penetrate to a depth of 30 to 50 inches. Runoff is very slow, and soil blowing is a hazard where the soils are tilled and exposed. The average annual rainfall is 12 to 16 inches, and the frost-free season is 250 to 300 days.

These soils are suited to irrigated pasture. They are also suited to alfalfa where the water table is kept below a depth of 5 feet.

The soils are drained by open drains and pumping. They can be irrigated only by surface irrigation. Applications of water should be frequent and light to

prevent the leaching of nutrients and raising the water table.

CAPABILITY UNIT IVw–6(17)

This unit consists of somewhat poorly drained, poorly drained, and very poorly drained soils in the Marcuse, Omni, Pescadero, Sacramento, and Solano series. These soils are moderately deep or deep and have slopes of less than 2 percent. They formed in small valleys and on rims of basins. They are moderately affected by salts and alkali. They have a surface layer of sand, loam, clay loam, silty clay, or clay and a subsoil of clay loam or clay.

Permeability is slow and very slow in the subsoil. The available water capacity is 4 to 9 inches. The water table is at a depth of 24 to more than 60 inches. Roots can penetrate to a depth of 20 to 60 inches. Runoff is slow and very slow, and the soils are ponded in places. The hazard of erosion is slight where the soils are tilled and exposed. The average annual rainfall is 10 to 19 inches, and the frost-free season is 250 to 300 days.

These soils are suited to irrigated pasture, sugar beets, milo, and barley. They are used mainly for irrigated pasture and some milo.

The soils should be leached with large amounts of water, and soil amendments should be applied to remove excess salts and alkali. Drainage is necessary to remove excess water before applying such soil amendments as gypsum or sulphur. Generally, the upper 12 inches of the surface layer can be reclaimed and maintained. Irrigation is necessary to prevent accumulation of salts. Applying irrigation water is difficult because of the slow or very slow permeability and slow water intake rate.

CAPABILITY UNIT VIe–1(15)

This unit consists of moderately well drained to somewhat excessively drained soils in the Alo, Altamont, Briones, Diablo, Dibble, Fontana, Gilroy, Kimball, Lodo, Los Gatos, Los Osos, Millsholm, Sehorn, and Tierra series. These soils have slopes of 5 to 50 percent. They formed on uplands and terraces. They have a surface layer and subsoil of loam, loamy sand, gravelly clay loam, clay loam, silty clay loam, and clay.

Permeability is rapid to very slow, and the available water capacity is 2 to 9 inches. Roots can penetrate to a depth of 10 to 60 inches. Runoff is medium to rapid, and the hazard of erosion is moderate to high where the soils are bare. The average annual rainfall is 12 to 25 inches, and the frost-free season is 250 to 300 days.

These soils are suited to range, wildlife habitat, and watershed.

The soils should be seeded to annual grasses and legumes if the plant cover has deteriorated.

CAPABILITY UNIT VIw–1(16)

Joice muck is the only soil in this capability unit. This very poorly drained soil formed on tidal areas adjacent to the Sacramento-San Joaquin River. It has slopes of less than 2 percent. It has a surface layer and subsurface layer of muck.

Permeability is moderate, and the available water capacity is 5 to 7 inches. The water table is at a depth of 12 to 36 inches. It limits the rooting depth of all plants except hydrophytic plants. Runoff is very slow, and the soil is ponded in places. There is no hazard of erosion. The average annual rainfall is 12 to 16 inches, and the frost-free season is 260 to 300 days.

This soil is suited to saltgrass pasture and wildlife habitat. It is used mainly for saltgrass pasture.

Levees and tidal gates should be used to control water at high tide and floods in winter.

CAPABILITY UNIT VIw–1(17)

This unit consists of poorly drained and very poorly drained soils in the Marcuse, Pescadero, and Solano series. These soils are moderately deep to deep and have slopes of less than 2 percent. They formed in small upland valleys and on rims of basins. They are strongly affected by salts and alkali. They have a surface layer of loam, clay loam, and clay and a subsoil of clay loam and clay.

Permeability is slow and very slow in the subsoil. The available water capacity is 4 to 7 inches. The water table is at a depth of 36 to more than 60 inches. Roots of salt-tolerant plants can penetrate to a depth of 36 to 60 inches. Runoff is slow to very slow, and the hazard of erosion is slight to moderate where the soils are tilled and exposed. The average annual rainfall is 10 to 19 inches, and the frost-free season is 250 to 300 days.

These soils are suited to irrigated pasture and dryland pasture. They are used mainly for dryland pasture.

Soil amendments such as gypsum or sulfur should be applied when the soils are leached with large amounts of water. Drainage is necessary to remove excess water. Irrigation helps prevent accumulation of salts. Leveling is necessary for good water management, but deep cuts that expose the subsoil should be avoided. Irrigated pasture should be planted to salt-tolerant grasses and legumes.

CAPABILITY UNIT VIIe–1(15)

This unit consists of somewhat excessively drained to well-drained soils in the Alo, Altamont, Briones, Felton, Fontana, Gaviota, Gilroy, Lodo, Los Gatos, Los Osos, Millsholm, Sehorn, and Vallecitos series and Rock outcrop. The soils have slopes of 5 to 75 percent. They formed on uplands. They have a surface layer and subsoil of loamy sand to clay.

Permeability is rapid to slow, and the available water capacity is 2 to 8 inches. Roots can penetrate to a depth of 10 to 60 inches. Runoff is rapid or very rapid, and the hazard of erosion is high or very high where the soils are bare. The average annual rainfall is 12 to 30 inches, and the frost-free season is 250 to 300 days.

These soils are suited to range, wildlife habitat, and watershed.

Grazing should be controlled to maintain an adequate cover of plants to reduce erosion. Suitable annual grasses and legumes should be seeded in critical areas to help control erosion.

CAPABILITY UNIT VIIIe–1(15)

This unit consists of somewhat excessively drained and excessively drained soils and quarries and rock outcrops on uplands. The soils have slopes of 15 to 75 percent. They are loamy sands, loams, silt loams, and clay loams.

Roots can penetrate to a depth of less than 20 inches. Runoff is rapid to very rapid. The hazard of erosion is high to very high where the soils are bare.

The areas are suited to wildlife habitat and watershed.

Preventing and controlling fires is the main concern of management.

CAPABILITY UNIT VIIIw—1(16)

Reyes silty clay and Fluvaquents are the only soils in this capability unit. These soils have slopes of less than 2 percent. They formed on tidal flats of the San Pablo Bay and on small islands in the river or sloughs on the delta. They are very poorly drained and are subject to inundation by high tides or to flooding in winter.

The Reyes soil has a surface layer and subsurface layer of silty clay. The Fluvaquents are stratified sandy loam, loam, silt loam, and silty clay loam and contain lenses of organic material.

These soils are suited to wildlife habitat and recreation areas.

Predicted Yields

Table 2 shows the predicted yields of the principal crops grown in the county under optimum management, the type of management that experience, field trials, and research findings have shown will give the highest yields currently possible.

The predicted yields are based on information furnished by farmers, on observations made by the soil scientists who surveyed the county, and on suggestions furnished by crop specialists in the Soil Conservation Service, the Agricultural Extension Service, and the California Agricultural Experiment Station. More information was available for some soils than for others. If little or no information was available for a particular soil, or if the specified crop is not grown on the soil, yield estimates are based on comparison with similar soils.

Several important limitations should be kept in mind when using the yield estimates in table 2. First, the figures are estimates, or predictions. Second, the figures are averages of what can be expected over a period of years; in any given year, the yield can be considerably higher or lower than the average. Third, there is considerable variation within some soils, and this was considered in making the predictions.

This information on yields is most useful immediately after the survey is released. New developments in crop breeding, in control of insects and disease, and in use of fertilizer, tillage, irrigation, and drainage can change yields.

The following paragraphs give the cropping sequence, rates of planting and fertilization, and amounts of irrigation water that were assumed in estimating the yields for the crops specified in table 2. All fertilizer needs are given in the elemental form—for example, pounds of actual nitrogen per acre.

IRRIGATED BARLEY. Barley is double cropped following other irrigated crops, such as tomatoes and head lettuce. Late in fall or early in winter, 80 to 100 pounds of barley are planted per acre. About 6 inches of irrigation water are applied in March and April, depending on rainfall. Tomatoes and head lettuce are then planted after barley has been harvested, usually in June. Fertilizers are generally not needed for maximum yields because of residual nitrogen used on the tomatoes and head lettuce.

CORN. About 15 pounds per acre of adapted hybrid seed are planted between April 15 and May 15. The seed is treated for protection against diseases and insects. About 200 pounds of nitrogen and 40 pounds of phosphorus are applied per acre. Merritt soils require 100 to 120 pounds of nitrogen per acre annually. Weeds are controlled during the growing season by two or three shallow cultivations or by chemicals. About 4 acre-feet of irrigation water per acre are used annually. Insecticides are applied as needed. Corn is harvested late in fall or early in winter. Cornfields are frequently flooded after the crop has been harvested to control weeds and reduce salts. Corn is an important food for wildlife. A few rows are left unharvested in some fields and used for pheasant cover.

ALFALFA. A typical cropping sequence consists of 4 years of alfalfa followed by 2 or 3 years of row or field crops. The seed is inoculated prior to seeding and is drilled at a rate of 10 to 12 pounds per acre. In the summer or in fall following planting, 15 to 25 pounds of phosphorus are applied. Alfalfa needs 3.5 acre-feet of irrigation water per acre annually on Brentwood, Capay, and Rincon soils and as much as 4.5 acre-feet per acre annually on Piper loamy sand.

GRAIN SORGHUM. Between May 1 and June 15, 15 to 20 pounds of treated seed of an adapted hybrid variety are planted per acre. From 75 to 125 pounds of nitrogen are applied per acre. Weeds are controlled by two or three shallow cultivations or by chemicals. Between 3.0 and 3.5 acre-feet of water per acre are applied annually. Some areas on the delta are flooded in winter to control weeds, to reduce salts, and to firm up the seedbed for spring cultivation.

SUGAR BEETS. Sugar beets require 100 pounds of nitrogen per acre per crop. About 3.5 acre-feet of irrigation water per acre are applied annually. Thinning is done either mechanically or by hand. Weeds are controlled by four to six shallow cultivations or by chemicals.

ASPARAGUS. Asparagus roots are planted in 6- to 8-foot rows. From 1 to 2 acre-feet of water per acre are applied. Fertilizers are not used. Weeds are controlled by light cultivation throughout the summer. Asparagus is harvested from late in spring through the early part of summer. After harvest, asparagus is allowed to grow to maturity, and the tops are cut off by a rotary mower after the first killing frost.

HEAD LETTUCE. Lettuce is planted late in June or early in July. It needs 4 to 4.5 acre-feet of irrigation

TABLE 2.—*Predicted average yields per acre of*

[No estimates are given for soils on which a particular crop is not grown or for soils to which the crop is not

Soil	Irrigated crops					
	Barley [1]	Corn	Alfalfa	Grain sorghum	Sugar beets	Asparagus
	Tons	*Cwt*	*Tons*	*Cwt*	*Tons*	*Tons*
Alo clay, 15 to 30 percent slopes						
Altamont clay, 9 to 15 percent slopes						
Altamont clay, 15 to 30 percent slopes						
Antioch loam, 0 to 2 percent slopes						
Antioch loam, 2 to 9 percent slopes						
Botella clay loam, 0 to 2 percent slopes						
Botella clay loam, 2 to 9 percent slopes						
Brentwood clay loam	3.0		8.5	60	26	
Brentwood clay loam, wet	3.0		7.5	60	26	
Capay clay, 0 to 2 percent slopes	3.0		7.0	60	25	
Capay clay, 2 to 9 percent slopes						
Capay clay, wet, 0 to 2 percent slopes	3.0		7.0	60	25	
Clear Lake clay						
Conejo clay loam, 0 to 2 percent slopes						
Conejo clay loam, 2 to 5 percent slopes						
Conejo clay loam, clay substratum, 0 to 2 percent slopes						
Cropley clay, 2 to 5 percent slopes						
Delhi sand, 2 to 9 percent slopes						
Diablo clay, 9 to 15 percent slopes						
Diablo clay, 15 to 30 percent slopes						
Egbert mucky clay loam		70		60		2.5
Kimball gravelly clay loam, 2 to 9 percent slopes						
Kingile muck		75		65		3.0
Laugenour loam			6.0			
Linne clay loam, 5 to 15 percent slopes						
Linne clay loam, 15 to 30 percent slopes						
Los Osos clay loam, 15 to 30 percent slopes						
Marcuse sand						
Marcuse clay					20	
Marcuse clay, strongly alkali						
Merritt loam		65		55		
Omni clay loam				55	22	
Pescadero clay loam						
Piper sand						
Piper loamy sand			6.0			
Piper fine sandy loam						
Rincon clay loam, 0 to 2 percent slopes	2.5		7.0			
Rincon clay loam, 2 to 9 percent slopes						
Rincon clay loam, 9 to 15 percent slopes						
Rincon clay loam, wet, 0 to 2 percent slopes	2.5		6.5			
Rindge muck		80		60		5.0
Ryde silt loam		70		60		5.0
Sacramento clay	2.0	70		65		5.0
Sacramento clay, alkali				55	20	
San Ysidro loam						
Sehorn clay, 15 to 30 percent slopes						
Shima muck				55		
Solano loam						
Solano loam, strongly alkali						
Sorrento silty clay loam	3.0		8.0		28	
Sorrento silty clay loam, sand substratum	2.5		7.0		24	
Sycamore silty clay loam	3.0		8.0	60	28	
Sycamore silty clay loam, clay substratum	2.0		6.0		24	
Tierra loam, 2 to 9 percent slopes						
Venice muck		80		60		5.0
Webile muck		80		60		
Zamora silty clay loam, 0 to 2 percent slopes	3.0		8.0		28	
Zamora silty clay loam, 2 to 5 percent slopes						

[1] Barley is double cropped with other irrigated crops, such as tomatoes and head lettuce. It is planted late in fall or early in winter and irrigated once during March or April. Tomatoes and lettuce are planted after the barley has been harvested, usually in June.

principal crops under optimum management

suited. Some soils are not listed because yield data were not available or the soils are not used for crops]

Irrigated crops—Continued							Dryfarmed crops	
Lettuce (head)	Tomatoes	Almonds	Apricots	Grapes	Walnuts	Pasture	Barley	Hay
Cartons	*Tons*	*Pounds*	*Tons*	*Tons*	*Cwt*	*AUM* [2]	*Cwt*	*Tons*
							18	
							22	2.0
							20	1.8
							18	1.5
							18	1.5
					28			2.0
500	30	2,200	8	1.5	25	18		
500	30							
500	25	1,800	7		15	18		
							24	2.0
500	25	1,500	7		12	18		
							24	2.5
							24	
							24	
							20	2.5
							24	2.0
		1,500			12			
							22	
							20	
	35					18–20		
							15	
	3					20		
							20	
							18	
							16	2.0
	18					14–16		
						16		
						10		
	25					20		
	25					18–20	20	
							14	
			700					
						16		
						12		
500	25	1,800	4		18	18		
							20	20
							18	
500	25							
	35					20		
	20					18		
	25					18		
						16		
						16	15	
							20	
	20					16		
						15		
						12		
500	28	2,000	5			18		
500	25	1,700	5		27	16		
500	25	1,700	4		18	18		
15–16	22	1,200	4		15	18		
							12	
	25					18–20		
	25					18–20		
400	28	2,000	5		22	18		
						16	18	2.0

[2] AUM is animal unit months, a term used to express the carrying capacity of pasture. It is the number of animal units, or 1,000 pounds of live weight, that can be carried on an acre of pasture each month without injury to the sod.

water per acre. During the growing season, 150 pounds of nitrogen are used. Weeds are controlled by cultivation.

TOMATOES. About 3.5 acre-feet of irrigation water per acre are applied annually. About 125 pounds of nitrogen and 40 pounds of phosphorus are applied as needed. Weeds are controlled by three to five shallow cultivations. Thinning is done by mechanical means or by hand. Insects are controlled as necessary.

ALMONDS. Almonds generally require about 40 pounds of nitrogen per acre annually. A winter cover crop of volunteer annual grasses and forbs reduces soil blowing and water erosion. Irrigation is limited to sprinklers on Delhi sand. Four or five applications totaling 18 inches of water are made. About 1.5 to 2 acre-feet of water per acre are applied.

APRICOTS. These trees require 40 to 60 pounds of nitrogen per acre annually. A winter cover crop is generally grown, but some orchards are being converted to permanent grass cover that helps reduce soil blowing and water erosion. Apricots use about 2 acre-feet of irrigation water per acre annually.

GRAPES. Grapes require 40 to 60 pounds of nitrogen per acre annually. The winter cover crop is volunteer annuals, grasses, and forbs that reduce soil blowing and water erosion. Grapes need about 1 acre-foot of irrigation water per acre annually.

WALNUTS. These trees require 100 to 150 pounds of nitrogen per acre annually, in two separate applications. A green manure crop of volunteer annual grasses and forbs is allowed to grow during the rainy season and is disked under in the spring.

IRRIGATED PASTURE. The seeding mixture usually consists of 2 pounds of alfalfa, 3 pounds of narrowleaf trefoil, or 2 pounds of Ladino clover and 8 pounds of Goars fescue or 5 pounds of Akaroa orchardgrass per acre. Eight pounds of prairie brome is sometimes used for quick cover. For Marcuse, Omni, and Solano soils, 5 pounds of narrowleaf trefoil and 10 pounds of Goars fescue per acre are usually planted. About 120 to 150 pounds of nitrogen and 30 to 40 pounds of phosphorus per acre are applied prior to irrigation in 4 or 5 applications. About 4 acre-feet of water per acre are applied annually.

New pastures are mowed to control weeds when plants are 6 inches high. They are grazed when plants are 8 to 10 inches high. Pastures are not grazed when wet. They are divided into three or more fields, grazing is rotated, and about 21 days of regrowth are allowed after each grazing. Animals are removed from a pasture when the plants are about 4 inches high. Maximum growth period and maximum stocking rates are between April 15 and October 15. Coarse stems are mowed to promote uniform growth and to prevent bunching. Droppings are scattered by light harrowing.

DRYFARMED BARLEY. Treated seed of improved varieties of barley is planted at a rate of 100 pounds per acre. A seedbed is prepared by disking after the first rains in November or December. Barley is planted in one or more years out of five. Stubble, volunteer barley, and annual grasses are grazed during the other years. Fertilizers are not used.

DRYFARMED HAY. Annual grasses, forbs, and volunteer grain are cut in June and used for supplemental feed for livestock. In some years dryfarmed barley fails to make a good crop because of small amounts or poor distribution of rain, and it is cut for hay.

Storie Index Ratings [2]

The soils of the county are listed in table 3 and are rated according to the Storie index (7). This index expresses numerically the relative degree of suitability of a soil for general intensive farming as it is practiced at the time of evaluation. The rating is based on soil characteristics only and is obtained by evaluating such factors as soil depth, surface texture, subsoil characteristics, drainage, salt and alkali content, and relief. Other factors, such as availability of water for irrigation, climate, and distance from markets, that might determine the desirability of growing certain plants in a given locality are not considered. Therefore, the index alone should not be considered as a direct indicator of land value. Where economic factors are known, however, the Storie index provides additional objective information for comparisons of land values.

Four general factors are considered in the index rating. These factors are A, the characteristics of the soil profile and soil depth; B, the texture of the surface soil; C, dominant slope of the soil; and X, other factors more readily subject to management or modification. In this county the X factors include drainage, flooding, salt and alkali content, general nutrient level of the soil, surface microrelief, and the hazard of erosion. Some soils have more than one of these limitations.

Each of the four general factors is evaluated on the basis of 100 percent. A rating of 100 percent expresses the most favorable or ideal condition, and lower percentage ratings are assigned for conditions that are less favorable for crop production. Factor ratings are selected from tables prepared by relating soil properties and plant growth.

The index rating for a soil is obtained by multiplying the four factors, A, B, C, and X; thus, any factor may dominate or control the final rating. For example, a soil such as Brentwood clay loam, wet, may have a good, permeable profile warranting a rating of 95 percent for factor A; a workable surface texture requiring some care in handling warranting a rating of 85 percent for factor B; a smooth, nearly level surface warranting a rating of 100 percent for factor C; and a slight to moderate drainage problem as a result of local seepage warranting a rating of 80 percent for factor X. Multiplying these four factors gives an index rating of 65 for this soil. If the drainage problem is corrected, the Storie index should be reevaluated by assigning a value of 100 to the X factor to reflect the changed conditions.

Soils are placed in grades according to their suitability for general intensive farming as shown by their

[2] By GORDON L. HUNTINGTON, lecturer and soil specialist, University of California, Davis.

TABLE 3.—*Storie index ratings of the soils*

[The symbol < means less than]

Map symbol	Soil	Soil rating factors				Index	Grade	Limitation in factor X
		A	B	C	X			
AaE	Alo clay, 15 to 30 percent slopes	60	60	65	100	23	4	
AaF	Alo clay, 30 to 50 percent slopes	50	60	40	100	12	5	
AaG	Alo clay, 50 to 75 percent slopes	50	60	20	100	6	6	
AbD	Altamont clay, 9 to 15 percent slopes	70	60	85	100	36	4	
AbE	Altamont clay, 15 to 30 percent slopes	70	60	65	100	27	4	
AcF	Altamont-Fontana complex, 30 to 50 percent slopes [1]	66	72	40	100	19	5	
AcG	Altamont-Fontana complex, 50 to 75 percent slopes [1]	67	70	20	100	9	6	
AdA	Antioch loam, 0 to 2 percent slopes	45	100	100	90x95	38	4	Nutrient level; alkali.
AdC	Antioch loam, 2 to 9 percent slopes	45	100	95	90x95	36	4	Nutrient level; alkali.
BaA	Botella clay loam, 0 to 2 percent slopes	95	85	100	100	81	1	
BaC	Botella clay loam, 2 to 9 percent slopes	95	85	95	100	77	2	
Bb	Brentwood clay loam	95	85	100	100	81	1	
Bc	Brentwood clay loam, wet	95	85	100	80	65	2	Drainage.
BdE	Briones loamy sand, 5 to 30 percent slopes	70	80	80	85	38	4	Nutrient level.
BdE2	Briones loamy sand, 15 to 30 percent slopes, eroded	60	80	65	85x75	20	4	Nutrient level; erosion.
BdF	Briones loamy sand, 30 to 50 percent slopes	60	80	40	85	16	5	Nutrient level.
BdF2	Briones loamy sand, 30 to 50 percent slopes, eroded	60	80	40	85x70	11	5	Nutrient level; erosion.
BeB	Briones fine sandy loam, 2 to 5 percent slopes	80	100	95	85	65	2	Nutrient level.
CaA	Capay clay, 0 to 2 percent slopes	90	60	100	100	54	3	
CaC	Capay clay, 2 to 9 percent slopes	90	60	95	100	51	3	
CbA	Capay clay, wet, 0 to 2 percent slopes	90	60	100	80	43	3	Drainage.
Cc	Clear Lake clay	90	60	100	90	49	3	Drainage.
CeA	Conejo clay loam, 0 to 2 percent slopes	100	85	100	100	85	1	
CeB	Conejo clay loam, 2 to 5 percent slopes	100	85	95	100	81	1	
ChA	Conejo clay loam, clay substratum, 0 to 2 percent slopes	80	85	100	100	68	2	
CkB	Cropley clay, 2 to 5 percent slopes	90	60	95	100	51	3	
CmE	Cut and fill land-Diablo complex, 9 to 30 percent slopes. Not rated.							
CnE	Cut and fill land-Los Osos complex, 9 to 30 percent slopes. Not rated.							
CoE	Cut and fill land-Millsholm complex, 9 to 30 percent slopes. Not rated.							
CoF	Cut and fill land-Millsholm complex, 30 to 50 percent slopes. Not rated.							
DaC	Delhi sand, 2 to 9 percent slopes	100	60	90	90	49	3	Nutrient level.
DdD	Diablo clay, 9 to 15 percent slopes	70	60	85	100	36	4	
DdE	Diablo clay, 15 to 30 percent slopes	70	60	65	100	27	4	
DdF	Diablo clay, 30 to 50 percent slopes	70	60	40	100	17	5	
DeE	Dibble silty clay loam, 15 to 30 percent slopes	65	90	65	95	36	4	Nutrient level.
DeF	Dibble silty clay loam, 30 to 50 percent slopes	65	90	40	95	22	4	Nutrient level.
Ea	Egbert mucky clay loam	90	90	100	40	32	4	Drainage.
FaG	Felton loam, 50 to 75 percent slopes	80	100	20	90	14	5	Nutrient level.
Fc	Fluvaquents	100	100	100	<10	<10	6	Flooding.
Fd	Fontana-Altamont complex [1]	64	76	65	100	32	4	
GaA	Garretson loam, 0 to 2 percent slopes	100	100	100	100	100	1	
GaB	Garretson loam, 2 to 5 percent slopes	100	100	95	100	95	1	
GbE	Gaviota sandy loam, 15 to 30 percent slopes	40	95	65	95	23	4	Nutrient level.
GbF	Gaviota sandy loam, 30 to 50 percent slopes	40	95	40	95	14	5	Nutrient level.
GbG	Gaviota sandy loam, 50 to 75 percent slopes	40	95	20	95	7	6	Nutrient level.
GcE	Gilroy clay loam, 15 to 30 percent slopes	60	90	65	100	35	4	
GcF	Gilroy clay loam, 30 to 50 percent slopes	60	90	40	100	22	4	
GcG	Gilroy clay loam, 50 to 75 percent slopes	50	90	20	100	9	6	
Ja	Joice muck	100	100	100	30x15	5	6	Drainage; flooding; salinity.
KaC	Kimball gravelly clay loam, 2 to 9 percent slopes	45	80	95	95	32	4	Nutrient level.
KaE	Kimball gravelly clay loam, 9 to 30 percent slopes	45	80	80	95	27	4	Nutrient level.

See footnotes at end of table.

TABLE 3.—*Storie index ratings of the soils*—Continued

Map symbol	Soil	Soil rating factors				Index	Grade	Limitation in factor X
		A	B	C	X			
Kb	Kingile muck	80	100	100	40	32	4	Drainage.
La	Laugenour loam	90	100	100	85	77	2	Drainage.
LbD	Linne clay loam, 5 to 15 percent slopes	60	85	85	100	43	3	
LbE	Linne clay loam, 15 to 30 percent slopes	60	85	65	100	33	4	
LcE	Lodo clay loam, 9 to 30 percent slopes	40	85	80	100	27	4	
LcF	Lodo clay loam, 30 to 50 percent slopes	40	85	40	100	14	5	
LcG	Lodo clay loam, 50 to 75 percent slopes	40	85	20	100	7	6	
Ld	Lodo-Rock outcrop complex	40	50	20–65	100	2–13	5–6	
LeE	Los Gatos loam, 15 to 30 percent slopes	60	100	65	95	37	4	Nutrient level.
LeF	Los Gatos loam, 30 to 50 percent slopes	60	100	40	95	23	4	Nutrient level.
LeG	Los Gatos loam, 50 to 75 percent slopes	60	100	20	95	11	5	Nutrient level.
LhE	Los Osos clay loam, 15 to 30 percent slopes	55	85	65	100	30	4	
LhF	Los Osos clay loam, 30 to 50 percent slopes	55	85	40	100	19	5	
LhG	Los Osos clay loam, 50 to 75 percent slopes	55	85	20	100	9	6	
Lk	Los Osos-Los Gatos complex [1]	57	92	20	97	10	5	Nutrient level.
Lm	Los Robles clay loam	95	85	100	100	81	1	
Ma	Marcuse sand	80	60	100	60x80	23	4	Drainage; alkali (subsoil).
Mb	Marcuse clay	90	50	100	60x60	16	5	Drainage; alkali.
Mc	Marcuse clay, strongly alkali	90	50	100	60x30	8	6	Drainage; alkali.
Md	Merritt loam	100	100	100	60	60	2	Drainage; flooding.
MeE	Millsholm loam, 15 to 30 percent slopes	40	100	65	95	25	4	Nutrient level.
MeF	Millsholm loam, 30 to 50 percent slopes	40	100	40	95	15	5	Nutrient level.
MeG	Millsholm loam, 50 to 70 percent slopes	40	100	20	95	8	6	Nutrient level.
Oa	Omni clay loam	90	85	100	80	61	2	Drainage.
Ob	Omni silty clay	90	70	100	80x60	25	4	Drainage; salinity.
PaC	Perkins gravelly loam, 2 to 9 percent slopes	70	70	95	95	44	3	Nutrient level.
PaD	Perkins gravelly loam, 9 to 15 percent slopes	70	70	85	95	39	4	Nutrient level.
Pb	Pescadero clay loam	40	85	100	80	27	4	Alkali.
Pc	Pescadero clay loam, strongly alkali	40	85	100	60	20	4	Alkali.
Pd	Piper sand	100	60	100	60	36	4	Salinity.
Pe	Piper loamy sand	100	80	100	40	32	4	Drainage.
Ph	Piper fine sandy loam	60	100	95	40	23	4	Drainage.
PkA	Positas loam, 0 to 2 percent slopes	55	100	100	95	52	3	Nutrient level.
PkC	Positas loam, 2 to 9 percent slopes	55	100	95	95	50	3	Nutrient level.
Qa	Quarry [2]	<10	6			<10	6	
Ra	Reyes silty clay	90	70	100	10	6	6	Tidal overflow.
RbA	Rincon clay loam, 0 to 2 percent slopes	80	85	100	100	68	2	
RbC	Rincon clay loam, 2 to 9 percent slopes	80	85	95	100	65	2	
RbD	Rincon clay loam, 9 to 15 percent slopes	80	85	90	100	61	2	
RcA	Rincon clay loam, wet, 0 to 2 percent slopes	80	85	100	80	54	3	Drainage.
Rd	Rindge muck	100	100	100	40	40	3	Drainage.
Re	Rock outcrop-Xerorthents association [2]					<10	6	
Rh	Ryde silt loam	100	100	100	50	50	3	Drainage.
Sa	Sacramento clay	85	60	100	90	49	3	Drainage.
Sb	Sacramento clay, alkali	85	60	100	90x80	39	4	Drainage; alkali.
Sc	San Ysidro loam	45	100	100	95	43	3	Nutrient level.
SdE	Sehorn clay, 15 to 30 percent slopes	70	60	65	100	27	4	
SdF	Sehorn clay, 30 to 50 percent slopes	70	60	40	100	17	5	
SdG	Sehorn clay, 50 to 75 percent slopes	60	60	20	100	7	6	
Se	Shima muck	80	100	100	40	32	4	Drainage.
Sh	Solano loam	40	100	100	80x80x90	23	4	Drainage; alkali; microrelief.
Sk	Solano loam, strongly alkali	40	100	100	80x60x90	17	5	Drainage; alkali; microrelief.
Sm	Sorrento silty clay loam	100	90	100	100	90	1	
Sn	Sorrento silty clay loam, sand substratum	80	90	100	100	72	2	
So	Sycamore silty clay loam	100	90	100	90	81	1	Drainage.
Sp	Sycamore silty clay loam, clay substratum	95	90	100	90	77	2	Drainage.
TaC	Tierra loam, 2 to 9 percent slopes	60	95	95	90	49	3	Nutrient level.
TaD	Tierra loam, 9 to 15 percent slopes	60	95	85	90	44	3	Nutrient level.
TaE	Tierra loam, 15 to 30 percent slopes	60	95	65	90	33	4	Nutrient level.
Ub	Urban land [2]					<10	6	
VaF	Vallecitos loam, 30 to 50 percent slopes	35	95	40	95	13	5	Nutrient level.
Vb	Venice muck	100	100	100	40	40	3	Drainage.
Wa	Webile muck	80	100	100	40	32	4	Drainage.
ZaA	Zamora silty clay loam, 0 to 2 percent slopes	95	90	100	100	86	1	
ZaB	Zamora silty clay loam, 2 to 5 percent slopes	95	90	95	100	81	1	

[1] Rated according to proportion of dominant soils in this complex.
[2] Rated nonagricultural because of unfavorable conditions of terrain or type of use.

Storie index ratings. The six grades and their range in index ratings are:

	Index rating
Grade 1	80 to 100
Grade 2	60 to 80
Grade 3	40 to 60
Grade 4	20 to 40
Grade 5	10 to 20
Grade 6	Less than 10

Soils of grade 1 are well suited to general intensive farming. Grade 2 soils are also well suited to farming, although they are not so desirable as soils of grade 1. Grade 3 soils are fairly well suited, grade 4 soils are poorly suited, and grade 5 soils are very poorly suited. Grade 6 soils and land types are not suited to farming.

Range [3]

About 37 percent of the acreage of Contra Costa County is used for range. Over half of this acreage is Altamont, Fontana, Lodo, Los Osos, and Millsholm soils. Alo, Diablo, Los Gatos, Gilroy, Sehorn, and Vallecitos are other important soils used for range. All of these soils are on uplands at elevations of 100 to 3,000 feet. Generally, the soils used for range are too steep or too shallow for cultivated crops. A significant acreage formerly used for grain and hay is now used for range.

Soils that have a high potential for forage are slightly acid to moderately alkaline clay loam or clay. They may be calcareous.

Soils that have a low potential for forage are generally loamy sand, such as Briones soils. The available water capacity is 1 to 3 inches, and depth to bedrock is less than 40 inches.

Management by range sites

Range sites are groups of soils that produce significantly different kinds or amounts of vegetation. Each site has a different potential for producing forage and requires different management.

Most of the important forage plants in Contra Costa County were introduced. The original forage plants were a mixture of perennials and annuals, but the introduced plants are mostly cool-weather annuals that take full advantage of the soil moisture while it is available, produce seed, and mature by the time the soils are dry. They furnish highly nutritious feed in the spring when they are green and growing, but after they mature their nutritional value is low.

The forage plants of the county are grouped into three classes: desirable, less desirable, and undesirable plants. Livestock graze selectively, seeking out the more palatable and nutritious plants. If grazing is not carefully regulated, the desirable plants are weakened or eliminated because they are not allowed to produce seed. Less desirable plants then increase. If grazing is continued, even the less desirable plants are thinned out or eliminated. The undesirable, unpalatable plants take their place, or the soil is left essentially bare.

[3] KENNETH E. ANDERSON, soil conservationist, Soil Conservation Service, helped prepare this section.

The soils in Contra Costa County have been grouped into seven range sites. The range sites are described in the following pages. The range site for each soil in the county is listed in the "Guide to Mapping Units" at the end of this survey.

Range sites are divided into phases because of differences in slope that necessitate different types of management. The steep phase of each site has slopes of 30 to 50 percent, and the very steep phase has slopes of more than 50 percent. The total production potential on the steep and very steep soils is essentially the same as on less sloping soils. It is necessary, however, to keep more residue on the surface to reduce runoff and maintain production because the hazard of erosion increases as the slope becomes steeper.

Annual herbage production listed for the range sites varies because of variations in the amount and timing of the annual precipitation. It also varies from year to year because of variations in temperature.

CLAYEY RANGE SITE

This range site makes up about 37 percent of the range in the county. It is on rolling to very steep foothills east and north of Mount Diablo. Slopes range from 9 to 75 percent. About 7 percent of the acreage is steep, and 5 percent is very steep. Elevation ranges from 150 to 1,500 feet. The average annual rainfall is 12 to 25 inches.

The soils in this site are clays, silty clay loams, and clay loams. They range from slightly acid to moderately alkaline. Lime is in the subsoil of most of the soils and is throughout the profile in places. The available water capacity is 3.5 to 9.0 inches. Roots can penetrate to a depth of 20 to 60 inches. Also in this site are soils that vary either above or below ranges listed for each characteristic or quality. Areas of these soils are generally small and widely distributed. There are some rock outcrops in the site.

This site is open grassland that has a few scattered oaks. If the site is producing at potential, approximately 70 percent of the herbage is a mixture of soft chess, remnant perennial grasses, filaree, annual clover, and excellent stands of burclover and wild oats. Approximately 20 percent is ripgut brome, wild barley, annual fescue, red brome, wildcarrot, annual lupine, and other less desirable plants. The rest of the herbage is tarweed, fiddleneck, popcorn flower, vinegarweed, turkeymullein, thistles, mustard, and other undesirable plants. Heavy infestations of artichoke thistle are on some areas.

The soils in this site that have slopes of less than 40 percent can be seeded to suited annual grasses and legumes. Forage plants on these soils respond well to applications of nitrogen and phosphorus. Soils that receive an average annual rainfall of more than 16 inches and that have slopes of less than 30 percent are suited to Hardinggrass and Perlagrass if a good seedbed can be prepared mechanically.

This site is divided into two precipitation zones. In the 12- to 16-inch precipitation zone, the estimated total annual production of air-dry herbage is 2,400 pounds per acre in favorable years and 1,400 pounds

per acre in unfavorable years. In the 16- to 25-inch precipitation zone, the estimated production is 4,000 pounds per acre in favorable years and 2,400 pounds per acre in unfavorable years.

When this site is producing at potential, it has very little brush or oak. The total herbage production is available feed for livestock and wildlife. Adequate residue should be left on the soils to protect the site against deterioration and erosion.

FINE LOAMY RANGE SITE

This range site makes up about 18 percent of the range in the county. It is mainly on hilly to very steep uplands in the western part of the county. Slopes range from 15 to 75 percent. About 5 percent of the acreage is steep, and 5 percent is very steep. Elevation ranges from 100 to 2,500 feet. The average annual rainfall is 14 to 25 inches.

The soils in this site are in the Los Osos series. They are well-drained clay loams. They are medium acid to neutral. Permeability is slow in the clay subsoil, and the available water capacity is 4 to 7 inches. Runoff is medium to rapid. Roots can penetrate to a depth of 24 to 40 inches. Also in this site are soils that vary either above or below ranges listed for each characteristic or quality. Areas of these soils are generally small.

This site has a cover of annual grass, wild oats, forbs, shrubs, and oak. If the site is producing at potential, approximately 70 percent of the herbage is a mixture of soft chess, remnant perennial grasses, filaree, annual clover, burclover, and wild oats. Approximately 20 percent is ripgut brome, wild barley, annual fescue, red brome, wildcarrot, annual lupine, and other less desirable plants. The rest of the herbage is tarweed, fiddleneck, vinegarweed, turkeymullein, thistles, mustard, and other undesirable plants.

The soils in this site that have slopes of less than 50 percent can be seeded to suited annual grasses and legumes. Forage plants on these soils respond well to applications of nitrogen and phosphorus. Soils that receive an average annual rainfall of more than 16 inches and that have slopes of less than 30 percent are suited to such perennial grasses as Hardinggrass and Perlagrass if a good seedbed can be prepared mechanically.

This site is divided into two precipitation zones. In the 14- to 20-inch precipitation zone, the estimated total annual production of air-dry herbage is 2,600 pounds per acre in favorable years and 1,500 pounds per acre in unfavorable years. In the zone that receives more than 20 inches of precipitation annually, the estimated production is 3,500 pounds per acre in favorable years and 2,000 pounds per acre in unfavorable years.

When this site is producing at potential, it has open to scattered stands of brush or oak. At least 90 percent of the total herbage production is available feed for livestock and wildlife. Thick stands of oak and shrubs on some areas reduce the amount of usable forage to 50 percent. Adequate residue should be left on the soils to protect the site against deterioration and erosion.

LOAMY RANGE SITE

This range site makes up about 13 percent of the range in the county. It is on hilly to very steep uplands mainly in the western part of the county. Slopes range from 15 to 75 percent. About 15 percent of the acreage is steep, and 15 percent is very steep. Elevation ranges from 500 to 2,500 feet. Average annual precipitation is 15 to 25 inches.

The soils in this site are well-drained loams, clay loams, and silty clay loams. They range from medium acid to neutral. Permeability is moderately slow or slow in the subsoil, and the available water capacity is 4 to 7 inches. Runoff is medium to rapid. Roots can penetrate to a depth of 20 to 40 inches. Also in this site are soils that vary either above or below ranges listed for each characteristic or quality. Areas of these soils are generally small.

This site has a cover of annual grass, oak, and brush. If the site is producing at potential, approximately 70 percent of the herbage is a mixture of soft chess, remnant perennial grasses, filaree, annual clover, and wild oats. Approximately 20 percent is rupgut brome, wild barley, annual fescue, brome, wildcarrot, annual lupine, and other less desirable plants. The rest of the herbage is nitgrass, tarweed, fiddleneck, vinegarweed, turkeymullein, thistles, mustard, and other undesirable plants.

The soils in this site that have slopes of less than 50 percent can be seeded to suited annual grasses and legumes. Forage plants on these soils respond well to applications of nitrogen and phosphorus. Soils that receive an average annual rainfall of more than 16 inches and that have slopes of less than 30 percent are suited to such perennial grasses as Hardinggrass and Perlagrass if a good seedbed can be prepared mechanically.

This site is divided into two precipitation zones. In the 15- to 20-inch precipitation zone, the estimated total annual production of air-dry herbage is 2,000 pounds per acre in favorable years and 1,200 pounds per acre in unfavorable years. In the zone that receives more than 20 inches of precipitation annually, the estimated production is 2,500 pounds per acre in favorable years and 1,300 pounds per acre in unfavorable years.

When this site is producing at potential, the total herbage production is available feed for livestock and wildlife; there are no dense stands of oak or shrubs. Dense stands of oak and shrubs on this site reduce the amount of usable forage by 60 percent. Adequate residue should be left on the soils to protect the site against deterioration and erosion.

SANDY RANGE SITE

This range site makes up about 2 percent of the range in the county. It is gently sloping to very steep. Slopes range from 5 to 50 percent. About 25 percent of the acreage is steep. Elevation ranges from 500 to 1,000 feet. The average annual rainfall is 14 to 20 inches.

The soils in this site are in the Briones series. They are strongly acid to slightly acid. The available water capacity is 1 to 4 inches. Runoff is medium to very rapid. Roots can penetrate to a depth of 10 to 40 inches. Also in this site are soils that vary either above or below ranges listed for each characteristic or quality. Areas of these soils are generally small.

This site has a cover of forbs, annual grass, and scattered oaks, and a few areas have thick stands of brush. If the site is producing at potential, approximately 20 percent of the herbage is filaree and 50 percent is soft chess, wild oats, and remnant perennial grasses. Approximately 30 percent is ripgut brome, wild barley, annual lupine, tarweed, fiddleneck, and turkeymullein.

The soils in this site cannot be seeded to perennial grasses, but such annual grasses and legumes as Lana vetch can be established on the soils that have slopes of less than 30 percent.

This site is in the 14- to 20-inch precipitation zone. The estimated total annual production of air-dry herbage is 1,000 pounds per acre iu favorable years and 400 pounds per acre in unfavorable years.

When this site is producing at potential, it does not have brush or trees. The total herbage production is available feed for livestock and wildlife. Adequate residue should be left on the soils to protect the site against deterioration and erosion.

SHALLOW COARSE LOAMY RANGE SITE

This range site makes up 2 percent of the range in the county. It is on hilly to very steep uplands. Slopes range from 15 to 75 percent. About 55 percent of the acreage is steep, and 35 percent is very steep. Elevation ranges from 100 to 2,500 feet. The average annual rainfall is 14 to 25 inches.

The soils in this site are in the Gaviota series. They are well-drained and somewhat excessively drained sandy loams. They are slightly acid or neutral. Permeability is moderately rapid in the subsoil. The available water capacity is 1.5 to 3 inches. Runoff is medium to rapid. Roots can penetrate to a depth of 10 to 20 inches. Also in this site are soils that vary either above or below ranges listed for each characteristic or quality. Areas of these soils are generally small.

This site has a cover of annual grass, forbs, and some oak. If the site is producing at potential, approximately 70 percent of the herbage is a mixture of soft chess, filaree, annual clover, and wild oats. Approximately 20 percent is ripgut brome, wild barley, annual fescue, red brome, wildcarrot, annual lupine, and other less desirable plants. The rest of the herbage is nitgrass, popcorn flower, vinegarweed, turkeymullein, and other undesirable plants.

The soils in this site are not suitable for seeding or fertilizing, because they are shallow and have a low available water capacity.

This site is divided into two precipitation zones. In the 14- to 20-inch precipitation zone, the estimated total annual production of air-dry herbage is 1,600 pounds per acre in favorable years and 800 pounds per acre in unfavorable years. In the 20- to 25-inch precipitation zone, the estimated production is 2,000 pounds per acre in favorable years and 1,200 pounds per acre in unfavorable years.

When this site is producing at potential, it has open to scattered stands of oak. Eighty-five percent of the total herbage production is available feed for livestock and wildlife. Adequate residue should be left on the soils to protect the site against deterioration and erosion.

SHALLOW FINE LOAMY RANGE SITE

This range site makes up about 20 percent of the range in the county. It is on strongly sloping to very steep uplands. Slopes range from 9 to 75 percent. About 40 percent of the acreage is steep, and 40 percent is very steep. Elevation ranges from 300 to 2,000 feet. The average annual rainfall is 14 to 25 inches.

The soils in this site are somewhat excessively drained and well-drained loams and clay loams. They range from strongly acid to neutral. Permeability is moderate to moderately slow in the subsoil, and the available water capacity is 2 to 4 inches. Runoff is medium to rapid. Roots can penetrate to a depth of 10 to 20 inches. Also in this site are soils that vary either above or below ranges listed for each characteristic or quality. Areas of these soils are generally small.

This site has a cover of annual grass, forbs, and scattered oaks. Dense stands of coyote brush are on a few areas. If the site is producing at potential, approximately 70 percent of the herbage is a mixture of soft chess, remnant perennial grasses, burclover, filaree, annual clover, and Spanish clover. Approximately 20 percent is ripgut brome, annual fescue, wild barley, wildcarrot, yarrow, and annual lupine. The rest of the herbage is nitgrass, silver hairgrass, dogtail, popcorn flower, fiddleneck, tarweed, turkeymullein, and thistles.

The soils in this site are not suitable for seeding to perennial grasses, because they are shallow and have a low available water capacity. Soils that have slopes of less than 30 percent can be seeded to annual grasses aud legumes.

This site is divided into two precipitation zones. In the 14- to 20-inch precipitation zone, the estimated total annual production of air-dry herbage is 2,000 pounds per acre in favorable years and 1,000 pounds per acre in unfavorable years. In the 20- to 25-inch precipitation zone, the estimated production is 2,400 pounds per acre in favorable years and 1,200 pounds per acre in unfavorable years.

When this site is producing at potential, it has open to scattered stands of oak or brush. Eighty-five percent of the total herbage production is available feed for livestock and wildlife. Adequate residue should be left on the soils to protect the site against deterioration and erosion.

CLAYPAN RANGE SITE

This range site makes up about 8 percent of the range in the county. It is on nearly level to moderately steep terraces. Slopes range from 0 to 30 percent. Elevation ranges from 10 to 1,200 feet. The average annual rainfall is 10 to 25 inches.

The soils in this range site are mainly moderately well drained, but some are well drained. They are loams and gravelly clay loams. They range from strongly acid in the surface layer to moderately alkaline in the subsoil. Permeability is very slow in the subsoil, and the available water capacity is 3.5 to 6 inches. Runoff is slow to rapid. Roots can penetrate to a depth of 12 to 30 inches. Also in this site is a soil that has a surface layer of slightly acid gravelly loam and a subsoil of slightly acid to neutral gravelly clay loam. Small areas of other soils that vary either above or below ranges listed for each characteristic or quality are also in the site.

This site has a cover of annual grass, forbs, and some scattered oaks. If the site is producing at potential, approximately 70 percent of the herbage is a mixture of soft chess, wild oats ,remnant perennial grasses, filaree, and annual clover. Approximately 20 percent is ripgut brome, wild barley, annual fescue, red brome, wildcarrot, annual lupine, and other less desirable plants. The rest of the herbage is nitgrass, fiddleneck, tarweed, turkeymullein, plantain, and other undesirable plants.

The soils in this site can be seeded to annual grasses and legumes. Most soils that receive an average annual rainfall of more than 16 inches are suited to such perennial grasses as Hardinggrass or Perlagrass if a good seedbed can be prepared mechanically. Forage plants respond well to applications of nitrogen and phosphorus.

This site is divided into two precipitation zones. In the 10- to 16-inch precipitation zone, the estimated total annual production of air-dry herbage is 1,500 pounds per acre in favorable years and 700 pounds per acre in unfavorable years. In the 16- to 25-inch precipitation zone, estimated production is 2,500 pounds per acre in favorable years and 1,400 pounds per acre in unfavorable years.

When this site is producing at potential, it has few oaks. Almost all of the total herbage production is available feed for livestock and wildlife. Adequate residues should be left on the soils to protect the site against deterioration and erosion.

Wildlife

Wildlife and fish are important in Contra Costa County and contribute directly and indirectly to the county's economy. They stimulate varied recreation activities, help control insect pests, and destroy weed seeds. Pheasants, ducks, and mourning doves are in the eastern part of the county. California quail are throughout the county. Columbian black-tailed deer, the only large animals in the county, are abundant in the central and western parts of the county. Bass, bluegill, and some channel catfish are stocked in ponds and reservoirs. Striped bass, black bass, and various sunfish, catfish, and nongame fish are plentiful in the numerous delta sloughs and channels in the eastern part of the county. Salmon, steelhead, and sturgeon are plentiful in the San Joaquin and Sacramento Rivers. Other wildlife, such as jackrabbits, ground squirrels, coyotes, meadowlarks, white-tailed kite, and numerous other birds, also live in the county.

In table 4, the soils of the county are rated according to their suitability for various kinds of plants and water developments that are used by open land wildlife, wetland wildlife, and rangeland wildlife. They are rated as *good, fair, poor,* or *very poor.* The following paragraphs give examples of the plants that form the habitat elements in table 4 and describe the properties of soils suitable for water developments.

Grain and seed crops that are valuable for wildlife are corn, barley, oats, sorghum, soybeans, wheat, and other crops grown for grain or seed.

Domestic grasses and legumes provide food and cover for wildlife. Grasses and legumes planted in the county include alfalfa, annual ryegrass, blando brome, clover, Hardinggrass, and Lana vetch.

Wild herbaceous plants that wildlife use for food and cover include burclover, filaree, vetch, wild mustard, wild oats, and other herbs common in the county.

Hardwood trees and the associated woody understory provide cover for wildlife and produce nuts or other fruit, buds, catkins, twigs, bark, or foliage that wildlife eat. They generally regenerate naturally, but they can be planted. Native plants include blue oak, valley oak, coast liveoak, Coulter pine, digger pine, poplar, black walnut, madrone, California buckeye, redberry, poison oak, blackberry, grape, snowberry, and hoary nightshade. Fruit-producing shrubs that are commonly available and suitable for planting on soils rated *good* are pyracantha, cotoneaster, autumn-olive, crabapple, and Russian-olive. The main soil properties that affect growth of hardwood trees and shrubs are the depth to which roots can penetrate, available water capacity, and wetness.

Shrubs and trees of certain varieties are valuable for wildlife because they produce a good seed crop or because they provide a source of browse. Among these are blackberry, buckbrush, chamise, manzanita, multiflora rose, quailbush, toyon, scrub oak, elderberry, and hollyleaf cherry.

Wetland plants that provide food and cover for wildlife include alkali bulrush, fat hen, pickleweed, watergrass, and others.

Shallow water areas are generally dependent upon the ability of the soil to hold water for a pond without excessive losses through deep percolation. The water level in the pond can be readily controlled to within 2 feet of the water table.

Impounded farm ponds are not included in table 4. They are important in the county for producing fish, including bluegill, bass, and channel catfish. For information on soil properties that affect construction of farm ponds, see the section "Engineering Uses of the Soils."

In table 4, the soils are rated according to their suitability for the three groups of wildlife in the county. These ratings are based on the suitability of the soils for habitat elements for the particular group of wildlife. For example, the rating of the suitability of a soil for openland wildlife is based on its suitability for grain and seed crops, domestic grasses and legumes, and wild herbaceous plants.

Engineering Uses of the Soils

This section is useful to those who need information about soils for use as structural material or as the foundation upon which structures are built. Among those who can benefit from this section are members of planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among properties of soils important in engineering are permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, and soil slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section can help readers to—

1. Select potential residential, industrial, commercial, and recreation areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
4. Correlate performance of structures already built with properties of the soil on which they are built for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
5. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
6. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 5, 6, and 7, which show, respectively, several estimated soil properties significant in engineering, interpretations for various engineering uses, and results of engineering laboratory tests on soil samples.

This information, along with the soil map and other parts of this survey, can be used to make interpretations in addition to those given in tables 5 and 6, and it also can be used in making other useful maps.

This information, however, does not eliminate the need for further investigations at sites selected for engineering works, especially works that involve heavy loads or that require excavation to depths greater than those shown in the tables, generally depths of more than 6 feet. Also, inspection of sites, especially small ones, is necessary because many delineated areas of a given soil mapping unit contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this survey have special meaning to soil scientists. The Glossary defines many of these terms.

Engineering soil classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system (*2*) used by Soil Conservation Service engineers, the Department of Defense, and others, and the AASHTO system (*1*) adopted by the American Association of State Highway and Transportation Officials.

In the Unified system soils are classified according to grain-size distribution, plasticity, liquid limit, and organic-matter content. Soils are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. In this system GP, GW, SP, and SW are clean gravels and sands. GM, GC, SM, and SC are gravels and sands that have a significant amount of nonplastic and plastic fines. ML and CL are nonplastic and plastic fine materials that have a low liquid limit, and MH and CH are nonplastic and plastic fine-textured soils that have a high liquid limit. Soils on the borderline between two classes are designated by symbols for both classes; for example, CL–ML.

The AASHTO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic groups ranging from A–1 through A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A–7, are clay soils that have low strength when wet and are the poorest soils for subgrade. One organic group, A8, is also recognized. Where laboratory data are available to justify a further breakdown, the A–1, A–2, and A–7 groups are divided as follows: A–1–a, A–1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5 and A–7–6.

Estimated soil properties significant in engineering

Several estimated soil properties significant in engineering are given in table 5. These estimates are made for typical soil profiles, by layers sufficiently different to have different significance for soil engineering. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. Following are explanations of some of the columns in table 5.

Depth to bedrock is the distance from the surface of the soil to the upper surface of the rock layer.

Depth to seasonal high water table is the distance from the surface of the soil to the highest level that ground water reaches in the soil in most years.

USDA texture is described in table 5 in the standard terms used by the Department of Agriculture (*8*). These terms take into account relative percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, "gravelly loamy sand." "Sand," "silt," "clay," and some of the other terms used in USDA textural classi-

TABLE 4.—*Suitability of the soils for elements*

Soil series and map symbols	Elements of wildlife habitat			
	Grain and seed crops	Domestic grasses and legumes	Wild herbaceous plants	Hardwood trees
Alo:				
AaE	Fair	Good	Poor	Good
AaF	Poor	Fair	Poor	Good
AaG	Very poor	Very poor	Poor	Good
Altamont:				
AbD	Fair	Good	Poor	Good
AbE	Fair	Good	Poor	Good
AcF	Poor	Fair	Poor	Good
AcG	Very poor	Very poor	Poor	Good
For ratings of the Fontana part of AcF and AcG, see the Fontana series.				
Antioch:				
AdA	Fair	Fair	Fair	Fair
AdC	Poor	Poor	Fair	Fair
Botella:				
BaA	Good	Good	Good	Good
BaC	Good	Good	Good	Good
Brentwood: Bb, Bc	Good	Good	Good	Good
Briones:				
BdE	Poor	Fair	Fair	Fair
BdE2, BdF, BdF2	Very poor	Very poor	Poor	Poor
BeB	Fair	Good	Good	Fair
Capay:				
CaA, CbA	Good	Good	Poor	Poor
CaC	Good	Good	Poor	Good
Clear Lake: Cc	Good	Good	Poor	Good
Conejo:				
CeA, ChA	Good	Good	Good	Good
CeB	Good	Good	Good	Good
Cropley: CkB	Good	Good	Poor	Good
Cut and fill land: CmE, CnE, CoE, CoF. Cut and fill land is too variable to be rated. For ratings of the Diablo part of CmE, see DdD and DdE in the Diablo series. For ratings of the Los Osos part of CnE, see LhE in the Los Osos series. For ratings of the Millsholm part of CoE and CoF, see MeE and MeF in the Millsholm series.				
Delhi: DaC	Fair	Good	Good	Fair
Diablo:				
DdD, DdE	Fair	Good	Poor	Good
DdF	Poor	Fair	Poor	Good
Dibble:				
DeE	Fair	Good	Good	Good
DeF	Poor	Fair	Good	Good
Egbert: Ea	Good	Good	Good	Very poor
Felton: FaG	Very poor	Very poor	Good	Good
Fluvaquents: Fc	Very poor	Very poor	Very poor	Very poor
Fontana-Altamont complex: Fd	Fair	Good	Good	Fair
For ratings of the Altamont part, see AbD and AbE in the Altamont series.				

of wildlife habitat and kinds of wildlife

Elements of wildlife habitat—Continued			Openland wildlife	Wetland wildlife	Rangeland wildlife
Shrubs	Wetland plants	Shallow water areas			
Poor	Very poor	Very poor	Fair	Very poor	Poor.
Poor	Very poor	Very poor	Poor	Very poor	Poor.
Poor	Very poor	Very poor	Poor	Very poor	Poor.
Poor	Very poor	Very poor	Fair	Very poor	Poor.
Poor	Very poor	Very poor	Poor	Very poor	Poor.
Poor	Very poor	Very poor	Poor	Very poor	Poor.
Poor	Very poor	Very poor	Poor	Very poor	Poor.
Fair	Good	Good	Fair	Good	Fair.
Fair	Poor	Very poor	Poor	Very poor	Fair.
Good	Good	Good	Good	Good	Good.
Good	Poor	Very poor	Good	Very poor	Good.
Good	Good	Good	Good	Good	Good.
Fair	Very poor	Very poor	Poor	Very poor	Fair.
Poor	Very poor	Very poor	Very poor	Very poor	Poor.
Good	Very poor	Very poor	Good	Very poor	Fair.
Poor	Good	Good	Good	Good	Poor.
Poor	Poor	Very poor	Good	Very poor	Poor.
Poor	Good	Good	Good	Good	Good.
Good	Good	Good	Good	Good	Good.
Good	Poor	Very poor	Good	Very poor	Good.
Poor	Poor	Very poor	Good	Very poor	Poor.
Good	Very poor	Very poor	Fair	Very poor	Good.
Poor	Very poor	Very poor	Fair	Very poor	Poor.
Poor	Very poor	Very poor	Poor	Very poor	Poor.
Good	Very poor	Very poor	Good	Very poor	Good.
Good	Very poor	Very poor	Fair	Very poor	Good.
Poor	Good	Good	Good	Good	Fair.
Good	Very poor	Very poor	Poor	Very poor	Good.
Very poor	Good	Fair	Very poor	Good	Very poor.
Good	Very poor	Very poor	Good	Very poor	Good.

TABLE 4.—*Suitability of the soils for elements*

Soil series and map symbols	Elements of wildlife habitat			
	Grain and seed crops	Domestic grasses and legumes	Wild herbaceous plants	Hardwood trees
Garretson:				
GaA	Good	Good	Good	Good
GaB	Good	Good	Good	Good
Gaviota:				
GbE	Poor	Fair	Fair	Poor
GbF, GbG	Very poor	Very poor	Fair	Poor
Gilroy:				
GcE	Fair	Good	Good	Good
GcF	Poor	Fair	Good	Good
GcG	Very poor	Very poor	Good	Good
Joice: Ja	Poor	Poor	Very poor	Very poor
Kimball:				
KaC	Fair	Fair	Poor	Fair
KaE	Poor	Fair	Poor	Fair
Kingile: Kb	Good	Good	Good	Very poor
Laugenour: La	Good	Good	Good	Good
Linne: LbD, LbE	Fair	Good	Good	Good
Lodo:				
LcE	Poor	Good	Fair	Fair
LcF, LcG, Ld	Very poor	Fair	Fair	Fair
Rock outcrop part of Ld is too variable to be rated.				
Los Gatos:				
LeE	Fair	Good	Good	Good
LeF	Poor	Fair	Good	Good
LeG	Very poor	Fair	Good	Good
Los Osos:				
LhE	Fair	Fair	Good	Good
LhF	Poor	Fair	Good	Good
LhG, Lk	Very poor	Very poor	Good	Good
For ratings of the Los Gatos part of Lk, see LeG in the Los Gatos series.				
Los Robles: Lm	Good	Good	Good	Good
Marcuse:				
Ma, Mb	Poor	Fair	Very poor	Very poor
Mc	Very poor	Poor	Very poor	Very poor
Merritt: Md	Good	Good	Good	Poor
Millsholm:				
MeE	Poor	Fair	Fair	Fair
MeF, MeG	Very poor	Very poor	Fair	Fair
Omni:				
Oa	Good	Good	Good	Fair
Ob	Poor	Fair	Very poor	Very poor
Perkins: PaC, PaD	Fair	Good	Good	Good
Pescadero:				
Pb	Poor	Fair	Very poor	Very poor
Pc	Very poor	Poor	Very poor	Very poor
Piper:				
Pd	Poor	Fair	Poor	Very poor
Pe	Poor	Fair	Good	Very poor
Ph	Poor	Good	Good	Very poor

of wildlife habitat and kinds of wildlife—Continued

Elements of wildlife habitat—Continued			Openland wildlife	Wetland wildlife	Rangeland wildlife
Shrubs	Wetland plants	Shallow water areas			
Good	Good	Good	Good	Good	Good.
Good	Poor	Very poor	Good	Very poor	Good.
Fair	Very poor	Very poor	Fair	Very poor	Fair.
Fair	Very poor	Very poor	Poor	Very poor	Fair.
Good	Very poor	Very poor	Good	Very poor	Good.
Good	Very poor	Very poor	Fair	Very poor	Good.
Good	Very poor	Very poor	Fair	Very poor	Good.
Very poor	Good	Good	Poor	Good	Very poor.
Fair	Very poor	Very poor	Poor	Very poor	Poor.
Fair	Very poor	Very poor	Poor	Very poor	Poor.
Very poor	Good	Good	Good	Good	Poor.
Good	Good	Fair	Good	Good	Fair.
Good	Very poor	Very poor	Good	Very poor	Good.
Fair	Very poor	Very poor	Fair	Very poor	Fair.
Fair	Very poor	Very poor	Poor	Very poor	Fair.
Good	Very poor	Very poor	Good	Very poor	Good.
Good	Very poor	Very poor	Fair	Very poor	Good.
Good	Very poor	Very poor	Poor	Very poor	Good.
Good	Very poor	Very poor	Fair	Very poor	Good.
Good	Very poor	Very poor	Fair	Very poor	Good.
Good	Very poor	Very poor	Poor	Very poor	Good.
Good	Good	Good	Good	Good	Good.
Poor	Good	Good	Poor	Good	Very poor.
Very poor	Fair	Fair	Very poor	Fair	Very poor.
Poor	Good	Good	Good	Good	Fair.
Fair	Very poor	Very poor	Fair	Very poor	Fair.
Fair	Very poor	Very poor	Poor	Very poor	Fair.
Fair	Good	Good	Good	Good	Fair.
Very poor	Good	Good	Poor	Good	Very poor.
Good	Very poor	Very poor	Good	Very poor	Good.
Poor	Good	Good	Poor	Good	Very poor.
Poor	Fair	Fair	Very poor	Fair	Very poor.
Fair	Good	Fair	Poor	Fair	Poor.
Fair	Good	Fair	Poor	Fair	Fair.
Fair	Good	Fair	Fair	Fair	Fair.

TABLE 4.—*Suitability of the soils for elements*

Soil series and map symbols	Elements of wildlife habitat			
	Grain and seed crops	Domestic grasses and legumes	Wild herbaceous plants	Hardwood trees
Positas:				
PkA	Fair	Good	Fair	Fair
PkC	Poor	Fair	Fair	Fair
Quarry: Qa. Too variable to be rated.				
Reyes: Ra	Very poor	Very poor	Very poor	Very poor
Rincon:				
RbA, RcA	Good	Good	Good	Good
RbC	Fair	Good	Good	Good
RbD	Fair	Good	Good	Good
Rindge: Rd	Good	Good	Good	Very poor
Rock outcrop: Re. Ratings are for the Xerorthents part of the association. The Rock outcrop part is too variable to be rated.	Very poor	Very poor	Poor	Very poor
Ryde: Rh	Good	Good	Good	Very poor
Sacramento:				
Sa	Good	Fair	Good	Very poor
Sb	Poor	Fair	Fair	Very poor
San Ysidro: Sc	Fair	Good	Fair	Fair
Sehorn:				
SdE	Fair	Good	Poor	Good
SdF	Poor	Fair	Poor	Good
SdG	Very poor	Very poor	Poor	Good
Shima: Se	Good	Good	Good	Very poor
Solano:				
Sh	Poor	Good	Very poor	Very poor
Sk	Very poor	Poor	Very poor	Very poor
Sorrento:				
Sm	Good	Good	Good	Good
Sn	Good	Good	Good	Good
Sycamore: So, Sp	Good	Good	Good	Good
Tierra:				
TaC, TaD	Fair	Good	Good	Good
TaE	Poor	Fair	Good	Good
Urban land: Ub. Not rated.				
Vallecitos: VaF	Very poor	Very poor	Fair	Fair
Venice: Vb	Good	Good	Good	Very poor
Webile: Wa	Good	Good	Good	Very poor
Zamora:				
ZaA	Good	Good	Good	Good
ZaB	Good	Good	Good	Good

of wildlife habitat and kinds of wildlife—Continued

Elements of wildlife habitat—Continued			Openland wildlife	Wetland wildlife	Rangeland wildlife
Shrubs	Wetland plants	Shallow water areas			
Fair	Good	Good	Fair	Good	Fair.
Fair	Poor	Very poor	Fair	Very poor	Fair.
Very poor	Good	Good	Very poor	Good	Very poor.
Good	Good	Good	Good	Good	Good.
Good	Poor	Very poor	Good	Very poor	Good.
Good	Very poor	Very poor	Good	Very poor	Good.
Poor	Good	Good	Good	Good	Very poor.
Poor	Very poor	Very poor	Very poor	Very poor	Poor.
Poor	Good	Good	Good	Good	Very poor.
Fair	Good	Good	Good	Good	Very poor.
Poor	Good	Good	Poor	Good	Very poor.
Fair	Good	Good	Fair	Good	Fair.
Poor	Very poor	Very poor	Fair	Very poor	Poor.
Poor	Very poor	Very poor	Poor	Very poor	Poor.
Poor	Very poor	Very poor	Very poor	Very poor	Poor.
Poor	Good	Good	Good	Good	Very poor.
Poor	Good	Good	Poor	Good	Very poor.
Very poor	Fair	Fair	Very poor	Fair	Very poor.
Good	Good	Good	Good	Good	Good.
Good	Poor	Poor	Good	Poor	Good.
Good	Good	Good	Good	Good	Good.
Good	Very poor	Very poor	Good	Very poor	Good.
Good	Very poor	Very poor	Fair	Very poor	Good.
Fair	Very poor	Very poor	Poor	Very poor	Fair.
Very poor	Good	Good	Good	Good	Very poor.
Very poor	Good	Good	Good	Good	Very poor.
Good	Good	Good	Good	Good	Good.
Good	Poor	Very poor	Good	Very poor	Good.

TABLE 5.—*Estimated soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in of this table. The symbol > means more than; the symbol <

Soil series and map symbols	Depth to—		Depth from surface (typical profile)	USDA texture	Classification		Percentage larger than 3 inches
	Bedrock	Seasonal high water table			Unified	AASHTO	
	Feet	*Feet*	*Inches*				
Alo: AaE, AaF, AaG	2–3½	(1)	0–24 24	Clay Sandstone.	CL	A–7	0
*Altamont: AbD, AbE, AcF, AcG For properties of the Fontana part of AcF and AcG, see the Fontana series.	3½–5	(1)	0–48 48	Clay Shale.	CL	A–7	0
Antioch: AdA, AdC	>5	(1)	0–17 17–36 36–60	Loam Clay Clay loam	ML or CL CL CL	A–4 or A–6 A–7 A–6	0 0 0
Botella: BaA, BaC	5	(1)	0–68	Clay loam and silty clay loam.	CL	A–6	0
Brentwood:							
Bb	>5	(1)	0–60	Clay loam	CL	A–6	0
Bc	>5	3½–4	0–60	Clay loam	CL	A–6	0
Briones:							
BdE, BdE2, BdF, BdF2	2–3½	(1)	0–32 32	Loamy sand Sandstone.	SM	A–2	0
BeB	>5	2	0–34 34–60	Fine sandy loam Fine sandy loam	SM, SM–SC SM, SM–SC	A–4 A–4	0 0
Capay:							
CaA, CaC	>5	(1)	0–60	Clay	CL	A–7	0
CbA	>5	3½–4	0–60	Clay	CL	A–7	0
Clear Lake: Cc	>5	(1)	0–60	Clay	CL	A–7	0
Conejo:							
CeA, CeB	>5	(1)	0–60	Clay loam	CL	A–6	0
ChA	>5	(1)	0–40 40–60	Clay loam Clay	CL CL	A–6 A–7	0 0
Cropley: CkB	>5	(1)	0–60	Clay and heavy clay loam.	CL	A–7	0
*Cut and fill land: Estimates are for the fill areas in these units.							
CmE For properties of the Diablo part, see the Diablo series.	(3)	(1)	0–60	Clayey	CL	A–7	0–30
CnE For properties of the Los Osos part, see the Los Osos series.	(3)	(1)	0–60	Clayey	CL	A–6	0–30
CoE	(3)	(1)	0–60	Loamy	SC or CL	A–6	0–35
CoF For properties of the Millsholm parts of CoE and CoF, see the Millsholm series.	(3)	(1)	0–60	Loamy	GC, CL, or SC.	A–2 or A–6	0–65
Delhi: DaC	>5	(1)	0–60	Sand	SP–SM	A–3	0
Diablo: DdD, DdE, DdF	3½–5	(1)	0–42 42	Clay Shale.	CL	A–7	0
Dibble: DeE, DeF	1½–	(1)	0–10 10–30 30	Silty clay loam Silty clay loam and silty clay. Shale.	CL CL	A–6 A–6, A–	0 0

See footnotes at end of table.

significant in engineering

such mapping units can have different properties, and for this reason it is necessary to refer to other series as indicated in the first column means less than. Dashes indicate that tests were not made]

Percentage passing sieve—				Atterberg values		Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity to uncoated steel
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)	Liquid limit	Plasticity index						
				Percent		*Inches per hour*	*Inches per inch of soil*	*pH*	*Mmhos per cm at 25° C*		
100	95–100	90–100	85–95	40–50	25–30	0.06–0.2	0.17–0.18	6.1–7.3		High	High.
100	95–100	90–100	85–95	40–50	25–30	0.06–0.2	0.16–0.18	6.6–8.4	<2	High	High.
100	100	85–95	60–75	30–40	5–15	0.6–2.0	0.15–0.17	5.1–6.0		Low	High.
100	100	90–100	80–90	40–50	20–30	<0.06	0.02–0.03	6.1–9.0	<2	High	High.
100	100	90–100	70–80	25–35	10–15	0.2–0.6		7.9–9.0	2–4	Moderate	High.
100	100	85–95	70–80	30–40	15–20	0.2–0.6	0.18–0.20	5.6–7.3		Moderate	Moderate.
100	100	95–100	80–95	30–40	15–20	0.2–0.6	0.18–0.20	6.6–8.4	<2	High	High.
100	100	95–100	80–95	30–40	15–20	0.2–0.6	0.18–0.19	6.6–8.4	<2	High	High.
100	100	60–75	15–25	15–20	[2] NP	6.0–20	0.07–0.10	5.1–6.5		Low	High.
100	100	80–90	40–50	20–25	NP–5	2.0–6.0	0.11–0.18	5.1–8.4	<2	Low	High.
100	100	80–90	40–50	20–25	NP–5	0.2–0.6	0.01–0.03	6.6–8.4	<2	Low	High.
100	100	90–100	85–95	40–50	25–30	0.06–0.2	0.14–0.17	6.6–8.4	<2	High	High.
100	100	90–100	85–95	40–50	25–30	0.06–0.2	0.14–0.17	6.6–8.4	<2	High	High.
100	100	90–100	85–95	40–50	25–30	0.06–0.2	0.14–0.17	6.1–8.4	2–8	High	Very high.
100	100	90–100	70–80	30–40	10–20	0.2–0.6	0.17–0.20	6.1–7.3		Moderate	Moderate.
100	100	90–100	70–80	30–40	10–20	0.2–0.6	0.17–0.20	6.1–7.3		Moderate	Moderate.
100	100	90–100	85–95	40–50	25–30	0.06–0.2	0.02–0.03	7.9–8.4	<2	High	High.
100	100	90–100	85–95	40–50	25–30	0.06–0.2	0.14–0.17	5.6–8.4	<2	High	High.
80–100	70–100	60–100	55–95	40–50	25–30	<0.2	[3]	7.4–8.4	<2	High	High.
80–100	70–100	55–95	50–90	30–40	15–20	<0.2	[3]	6.1–7.8		High	High.
80–100	65–100	45–80	35–70	30–40	10–15	<0.2	[3]	6.1–7.8		Moderate	Moderate.
50–100	35–100	25–80	15–65	30–40	10–15	<0.2	[3]	6.1–7.8		Moderate	Moderate.
100	100	50–70	5–10	NP	NP	6.0–20	0.05–0.06	6.1–7.8	<2	Low	Low.
100	100	90–100	85–95	40–50	25–30	0.06–0.2	0.14–0.15	6.6–8.4	<2	High	High.
100	100	85–100	60–90	25–35	10–20	0.2–0.6	0.18–0.20	5.6–6.0		Moderate	Moderate.
90–100	85–100	70–100	65–95	30–45	15–30	0.06–0.2	0.17–0.19	6.1–7.3	<2	High	High.

TABLE 5.—*Estimated soil properties*

Soil series and map symbols	Depth to—		Depth from surface (typical profile)	USDA texture	Classification		Percentage larger than 3 inches
	Bedrock	Seasonal high water table			Unified	AASHTO	
	Feet	*Feet*	*Inches*				
Egbert: Ea	>5	1½–4	0–16	Mucky clay loam.	OL	A–8	0
			16–72	Silty clay and clay.	CL	A–7	0
Felton: FaG	3½–4	(1)	0–19	Loam	CL	A–6	0
		(1)	19–42	Gravelly clay loam.	SC or CL	A–6	0
			42	Sandstone.			
Fluvaquents: Fc. Properties are too variable to be estimated.							
*Fontana: Fd	1½–3	(1)	0–22	Silty clay loam	CL	A–6	0
			22	Sandstone.			
For properties of the Altamont part, see Altamont series.							
Garretson: GaA, GaB	>5	(1)	0–60	Loam	ML, CL–ML	A–4	0
Gaviota: GbE, GbF, GbG	1–1½	(1)	0–17	Sandy loam	SM	A–4	0
			17	Sandstone.			
Gilroy: GcE, GcF, GcG	1½–3½	(1)	0–29	Clay loam	CL	A–6	0
			29–40	Very gravelly clay loam.	GC	A–2	0
			40	Basic igneous rock.			
Joice: Ja	>5	1–3	0–60	Muck	Pt	A–8	
Kimball: KaC, KaE	>5	(1)	0–15	Gravelly clay loam.	CL	A–6	0
			15–45	Clay and gravelly clay.	CL	A–7	0
			45–60	Gravelly sandy clay loam.	SC	A–2	0
Kingile: Kb	>5	1–5	0–20	Muck	Pt	A–8	
			20–60	Silty clay	CL or OL	A–7	0
Laugenour: La	>5	(1)	0–20	Loam and silty clay loam.	CL–ML, CL	A–4, A–6	0
			20–30	Fine sandy loam and silt loam.	CL–ML, CL	A–4	0
			30–60	Loamy sand and sand	SM, SM–SP,	A–2	0
Linne: LbD, LbE	1½–3½	(1)	0–29	Clay loam	CL	A–6	0
			29	Shale.			
Lodo: LcE, LcF, LcG, Ld	1–1½	(1)	0–18	Clay loam	CL	A–6	0
			18	Sandstone.			
Properties of the Rock outcrop part of Ld are too variable for interpretations to be made.							
Los Gatos: LeE, LeF, LeG	1½–3½	(1)	0–27	Loam and clay loam	CL–ML, CL	A–4	0
			27	Sandstone.			
*Los Osos: LhE, LhF, LhG, Lk	2–3½	(1)	0–32	Clay loam and clay.	CL	A–7	0
			32	Sandstone.			
For properties of the Los Gatos part of Lk, see the Los Gatos series.							

See footnotes at end of table.

significant in engineering—Continued

Percentage passing sieve—				Atterberg values		Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity to uncoated steel
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)	Liquid limit	Plasticity index						
				Percent		*Inches per hour*	*Inches per inch of soil*	*pH*	*Mmhos per cm at 25° C*		
100	100	90–100	70–80	35–45	10–45	0.2–0.6	0.19–0.20	5.6–7.3		Moderate	Very high.
100	100	90–100	80–90	35–45	15–25	0.06–0.2	0.14–0.16	4.5–6.0 (7.9–8.4 below a depth of 46 inches)		High	Very high.
100	100	85–95	60–70	25–35	10–15	0.6–2.0	0.14–0.16	5.6–6.5		Low	Moderate.
60–75	50–70	50–60	40–60	30–35	10–15	0.2–0.6	0.13–0.14	5.6–6.5		Low	Moderate.
100	100	95–100	75–85	30–40	10–20	0.2–0.6	0.18–0.19	6.1–8.4	<2	Moderate	High.
100	100	85–95	70–75	25–35	5–10	0.6–2.0	0.15–0.17	6.1–7.8		Low	Low.
100	100	60–70	35–45	20–25	NP	2.0–6.0	0.14–0.16	6.1–7.3		Low	Very low.
100	10–100	80–100	70–80	30–40	15–20	0.2–0.6	0.16–0.17	6.1–6.5		Moderate	Moderate.
35–50	20–35	20–35	15–30	30–40	10–20	0.2–0.6	0.07–0.08	6.1–6.5		Low	Moderate.
						0.6–2.0	0.25–0.27	4.5–6.0	>16	High shrink, low swell.	Very high.
75–85	70–75	50–65	50–60	25–35	15–20	0.2–0.6	0.16–0.18	6.1–7.3		Moderate	Moderate.
75–100	70–100	65–90	60–80	40–50	25–35	<0.06	0.02–0.03	6.6–8.4	<2	High	High.
70–80	65–75	45–55	25–35	25–35	10–15	0.2–0.6		6.6–8.4	<2	Moderate	High.
						6.0–20	0.25–0.30	4.5–6.0		High shrink, low swell.	Very high.
100	100	95–100	90–95	40–50	20–30	0.06–0.2	0.02–0.03	5.6–6.0		High	Very high.
100	100	90–100	70–90	20–40	5–15	0.6–2.0	0.14 0.17	7.9–8.4	<2	Moderate	High.
100	100	75–90	50–80	15–25	5–10	0.6–2.0	0.10–0.12	7.9–8.4	<2	Low	High.
100	100	55–65	10–20	NP	NP	6.0–20	0.05–0.06	7.9–8.4	<2	Low	High.
100	100	90–100	70–80	30–40	15–20	0.2–0.6	0.19–0.21	7.9–8.4	<2	Moderate	High.
100	100	90–100	70–80	30–40	15–20	0.2–0.6	0.19–0.21	5.6–7.3		Moderate	Moderate.
100	100	85–95	65–75	15–25	5–10	0.2–0.6	0.16–0.17	5.6–6.5		Moderate	Moderate.
100	95–100	85–100	75–95	40–50	20–30	0.06–0.2	0.17–0.19	5.6–7.3		High	High.

TABLE 5.—*Estimated soil properties*

oil series and map symbols	Depth to—		Depth from surface (typical profile)	USDA texture	Classification		Percentage larger than 3 inches
	Bedrock	Seasonal high water table			Unified	AASHTO	
	Feet	*Feet*	*Inches*				
Los Robles: Lm	>5	(1)	0–62	Clay loam	CL	A–6	0
Marcuse:							
Ma	>5	3½–4	0–20	Sand	SP–SM, SM	A–2 or A–3	0
			20–60	Clay	CL	A–7	0
Mb, Mc	>5	3½–4	0–60	Clay	CL	A–7	0
Merritt: Md	>5	3½–5	0–60	Loam and silt loam.	CL–ML or ML	A–4	0
Millsholm: MeE, MeF, MeG	1–1½	(1)	0–12	Loam	ML	A–4	0
			12	Sandstone.			
Omni: Oa, Ob	>5	2½–4	0–60	Clay loam, sandy clay loam, silty clay, and clay.	CL	A–7	0
Perkins: PaC, PaD	>5	(1)	0–40	Gravelly loam and gravelly clay loam.	SC	A–6	0
			40–60	Weakly consolidated gravelly clay loam.	SC, CL	A–6	0
Pescadero: Pb, Pc	>5	4–5	0–43	Clay	CL	A–6 or A–7	0
			43–66	Sandy clay loam.	CL	A–6	0
Piper:							
Pd, Pe	>5	2½–4	0–60	Sand and loamy sand.	SM–SP, SM	A–2	0
h	>5	3–3½	0–38	Fine sandy loam.	SM	A–4	0
			38–60	Fine sand	SM	A–2	0
Positas: PkA, PkC	>5	(1)	0–21	Loam	CL–ML, CL	A–4	0
			21–60	Clay	CL	A–6	0
Quarry: Qa. Properties are too variable to be estimated.							
Reyes: Ra	>5	½–2	0–60	Silty clay high in organic matter.	OH or MH	A–7	0
Rincon: RbA, RbC, RbD, RcA	>5	(5)	0–12	Clay loam	CL	A–6	0
			12–29	Clay	CL	A–6 or A–7	0
			29–65	Silty clay loam	CL	A–6	0
Rindge: Rd	>5	1–4	0–60	Muck	Pt	A–8	
Rock outcrop: Re. Estimates are for Xerorthents part only.	0–1	(1)	0–10	Loam	ML	A–4	10–15
Ryde: Rh	>5	3½–4	0–60	Silt loam	CL–ML, ML or OL	A–4	0
Sacramento: Sa, Sb	>5	4–5	0–60	Clay	CH	A–7	0

See footnotes at end of table.

significant in engineering—Continued

Percentage passing sieve—				Atterberg values		Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity to uncoated steel
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)	Liquid limit	Plasticity index						
				Percent		*Inches per hour*	*Inches per inch of soil*	*pH*	*Mmhos per cm at 25° C*		
90–100	85–100	80–100	65–80	30–40	10–15	0.2–0.6	0.15–0.18	6.1–8.4	<2	Moderate	High.
100	100	50–70	5–15	NP	NP	6.0–20	0.04–0.06	6.1–7.3		Low	Low.
100	100	90–100	85–95	40–50	25–35	0.06–0.2	0.08–0.12	7.9–9.0	>16	High	Very high.
100	100	90–100	85–95	40–50	25–35	0.06–0.2	0.08–0.12	7.9–9.0	>16	High	Very high.
100	100	90–100	80–90	25–35	5–10	0.6–2.0	0.14–0.15	5.6–7.3	2	Low	High.
100	100	85–95	60–80	30–40	5–10	0.6–2.0	0.19–0.21	5.1–6.5		Low	High.
100	100	90–100	75–95	40–50	20–30	0.06–0.20	0.14–0.16	7.9–8.4	2–8	High	Very high.
75–90	55–75	45–60	35–50	30–40	10–15	0.2–0.6	0.12–0.15	5.6–7.8		Moderate	Moderate.
75–90	55–75	50–65	40–55	30–40	10–15	0.06–0.2	0.02–0.03	7.4–7.8		Moderate	Moderate.
100	100	95–100	80–90	35–45	20–30	0.06–0.2	0.11–0.15	6.1–9.0	>16	High	Very high.
95–100	90–100	85–95	50–60	25–35	10–15	0.2–0.6	0.09–0.13	7.9–9.0	>16	Moderate	Very high.
100	100	55–65	10–20	NP	NP	6.0–20	0.05–0.07	6.1–8.4	<4	Low	Very high.
100	100	70–80	40–50	20–30	NP–5	0.6–2.0	0.08–0.12	7.9–8.4	<4	Low	Very high.
100	100	60–70	15–25	NP	NP	0.06–0.2	0.04–0.06	7.9–8.4	<2	Low	High.
100	100	80–90	75–85	20–30	5–10	0.6–2.0	0.12–0.15	5.6–6.5		Moderate	Low.
90–100	80–100	70–95	70–90	30–40	20–25	<0.06	0.02–0.04	5.6–8.4	<2	High	High.
100	100	90–100	80–90	60–70	10–30	0.06–0.2	0.08–0.12	7.9–9.0	>16	High	Very high.
100	100	90–100	70–80	30–40	15–20	0.2–0.6	0.17–0.19	6.1–7.8	<2	Moderate	Moderate.
100	100	90–100	80–90	35–45	20–25	0.06–0.2	0.14–0.17	6.6–8.4	<2	High	High.
100	100	95–100	85–95	25–35	10–20	0.2–0.6	0.15–0.17	7.9–8.4	<2	Moderate	High.
						6.0–20	>0.20	4.5–6.0		High shrink, low swell.	Very high.
75–85	70–80	60–70	50–60	25–35	5–10	0.6–2.0	0.10–0.15	5.6–7.3		Low	Low.
100	100	90–100	75–95	25–35	5–10	0.6–2.0	0.15–0.17	5.6–6.5		Moderate	High.
100	100	95–100	90–100	60–70	30–40	0.06–0.2	0.14–0.15	6.1–8.4	<8	High	Very high.

TABLE 5.—*Estimated soil properties*

Soil series and map symbols	Depth to—		Depth from surface (typical profile)	USDA texture	Classification		Percentage larger than 3 inches
	Bedrock	Seasonal high water table			Unified	AASHTO	
	Feet	*Feet*	*Inches*				
San Ysidro: Sc	>5	(1)	0–15	Loam	CL–ML, ML	A–4	0
			15–54	Silty clay and clay.	CL	A–6	0
			54–80	Silty clay loam	CL	A–6	0
Sehorn: SdE, SdF, SdG	1½–3½	(1)	0–35	Clay	CL	A–7	0
			35	Shale.			
Shima: Se	>5	2–4	0–25	Muck	Pt	A–8	
			25–60	Sand	SP–SM	A–3	0
Solano: Sh, Sk	>5	3–4	0–9	Loam and clay loam.	CL–ML, ML	A–4	0
			9–60	Clay loam and silty clay loam.	CL	A–6 or A–7	0
Sorrento:							
Sm	>5	(1)	0–60	Silty clay loam and clay loam.	CL	A–6	0
Sn			0–40	Silty clay loam and clay loam.	CL	A–6	0
			40–60	Sand	SP–SM	A–3	0
Sycamore:							
So	>5	3½–5	0–66	Silty clay loam and silt loam.	ML or CL	A–4 or A–6	0
Sp	>5	3½–5	0–40	Silty clay loam and silt loam.	ML or CL	A–4 or A–6	0
			40–60	Clay	CL	A–6 or A–7	0
Tierra: TaC, TaD, TaE	>5	(1)	0–25	Loam and clay loam.	CL–ML or CL	A–4 or A–6	0
			25–59	Clay	CL	A–7	0
			59–71	Silty clay loam	CL	A–6	0
Urban land: Ub. Properties are too variable to be estimated.							
Vallecitos: VaF	1–1½	(1)	0–10	Loam and clay loam.	ML	A–4	0
			10–19	Clay	CL	A–6 or A–7	0
			19	Shale.			
Venice: Vb	>5	2–4	0–60	Muck	Pt	A–8	
Webile: Wa	>5	3–5	0–43	Muck	Pt	A–8	
			43–63	Clay and silty clay.	OH or MH	A–7 or A–8	0
Zamora: ZaA, ZaB	>5	(1)	0–46	Silty clay loam	CL	A–4 or A–6	0
			46–72	Silty clay loam and clay loam; gravelly in places.	CL or ML	A–4 or A–6	0

[1] No water table within the depth of observation, which is normally a depth of 5 feet unless limited by bedrock.
[2] NP means nonplastic.
[3] Variable.

significant in engineering—Continued

Percentage passing sieve—				Atterberg values		Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity to uncoated steel
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)	Liquid limit	Plasticity index						
				Percent		*Inches per hour*	*Inches per inch of soil*	*pH*	*Mmhos per cm at 25° C*		
100	100	85–95	60–70	25–35	5–10	0.6–2.0	0.14–0.16	6.1–8.4	<2	Low	High.
100	100	90–100	80–95	35–40	20–30	<0.06	0.02–0.03	6.1–8.4	<2	High	High.
100	100	95–100	85–95	30–40	15–20	0.2–0.6	0.02–0.03	7.4–8.4	<2	High	High.
100	100	90–100	85–95	40–45	20–25	0.06–0.2	0.17–0.20	6.1–7.3		High	High.
						6.0–20	0.28–0.30	4.5–5.5		High shrink, low swell.	Very high.
100	100	50–70	5–10	NP	NP	6.0–20	0.02–0.03	4.5–8.4	<2	Low	Very high.
100	100	85–95	60–70	25–35	5–10	0.6–2.0	0.10–0.12	5.6–8.4	8–16	Moderate	Very high.
100	100	90–100	70–90	35–45	15–25	<0.06	0.04–0.06	7.9–9.0	>16	High	Very high.
100	100	95–100	75–85	25–35	10–15	0.2–0.6	0.17–0.20	6.1–8.4	<2	Moderate	High.
100	100	95–100	75–85	25–35	10–15	0.2–0.6	0.17–0.20	6.1–8.4	<2	Moderate	High.
100	100	60–70	5–10	NP	NP	6.0–20	0.02–0.03	7.4–8.4	<2	Low	High.
100	100	90–100	80–90	30–40	5–15	0.2–0.6	0.15–0.18	6.6–8.4	<2	Moderate	High.
100	100	90–100	80–90	30–40	5–15	0.2–6.0	0.15–0.18	6.6–8.4	<2	Moderate	High.
100	100	90–100	85–95	35–45	20–30	0.06–0.2	0.14–0.16	7.4–8.4	<2	High	Very high.
100	100	85–95	60–75	20–30	5–15	0.6–2.0	0.15–0.17	5.1–6.0		Low	High.
100	95–100	90–100	80–90	40–50	25–30	<0.06	0.04–0.06	5.6–7.3		High	High.
100	90–100	80–90	75–85	25–35	10–20	0.2–0.6	0.12–0.14	7.9–8.4	<2	Moderate	High.
85–100	80–100	75–95	50–75	30–40	5–10	0.6–2.0	0.16–0.20	5.6–7.3		Low	Moderate.
90–100	85–100	80–95	75–90	35–45	20–25	0.06–0.2	0.16–0.20	5.6–6.5		High	High.
						6.0–2.0	0.25–0.35	4.5–5.0	<2	High shrink, low swell.	Very high.
						6.0–20	0.25–0.35	4.5–6.0	<2	High shrink, low swell.	Very high.
100	100	90–100	80–95	55–65	15–20	0.06–0.2	0.14–0.16	6.1–7.8	2–4	High	Very high.
100	100	95–100	85–95	30–40	10–20	0.2–0.6	0.17–0.19	6.1–8.4	<2	Moderate	High.
65–100	60–100	60–100	55–95	30–40	5–20	0.2–0.6	0.13–0.19	7.4–8.4	<2	Moderate	High.

[4] Pd is weakly cemented and moderately permeable (0.6–2.0) below a depth of 26 inches.
[5] In RbA, RbC, and RbD, no water table is within the depth of observation. In RcA, a seasonal high water table is at a depth of 3½ to 4½ feet.

TABLE 6.—*Engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in such column of

Soil series and map symbols	Degree and kind of limitations for—				Suitability as a source of—
	Local roads and streets	Septic tank filter fields	Dwellings without basement	Sanitary landfill (trench type)	Topsoil
Alo: AaE, AaF, AaG	Severe: slope; high shrink-swell potential; low strength.	Severe: slope; slow permeability; depth to rock.	Severe: slope; high shrink-swell potential.	Severe: clay; depth to rock; slope in AaF and AaG.	Poor: clay; slope.
*Altamont: AbD, AbE, AcF, AcG. For interpretations of the Fontana part of AcF and AcG, see the Fontana series.	Severe: high shrink-swell potential; low strength; slope in AbE, AcF, and AcG.	Severe: slow permeability; slope in AbE, AcF, and AcG.	Severe: high shrink-swell potential; slope in AbE, AcF, and AcG.	Severe: clay; depth to rock; slope in AcF and AcG.	Poor: clay; slope in AbE, AcF, and AcG.
Antioch: AdA, AdC	Severe: high shrink-swell potential; low strength in subsoil.	Severe: very slow permeability.	Severe: high shrink-swell potential in subsoil; moderate shrink-swell potential below subsoil.	Severe: clay subsoil.	Fair: loam over clay.
Botella: BaA, BaC	Severe: low strength.	Severe: moderately slow permeability.	Moderate: low strength; moderate shrink-swell potential.	Moderate: clay loam and silty clay loam.	Fair: clay loam over silty clay loam.
Brentwood: Bb	Severe: low strength; high shrink-swell potential.	Severe: moderately slow permeability.	Severe: high shrink-swell potential.	Moderate: clay loam.	Fair: clay loam
Bc	Severe: low strength; high shrink-swell potential.	Severe: moderately slow permeability; water table at a depth of 3½ to 4 feet.	Severe: high shrink-swell potential.	Severe: water table at depth of 3½ to 4 feet.	Fair: clay loam
Briones: BdE, BdE2, BdF, BdF2	Severe: slope	Severe: slope; depth to rock.	Severe: slope	Severe: depth to rock; rapid permeability; slope in BdF and BdF2.	Poor: loamy sand.

See footnote at end of table.

interpretations

mapping units may have different properties and limitations, and for this reason it is necessary to refer to other series as indicated in the first this table]

Suitability as a source of—Continued	Soil features affecting—				Hydrologic soil group
Road fill	Water retention		Drainage for crops and pasture	Irrigation	
	Embankments	Reservoir areas			
Poor: low strength; high shrink-swell potential; slope in AdF and AdG.	Medium to low shear strength and susceptibility to piping; low permeability; medium compressibility; fair to good compaction characteristics.	Slopes of 15 to 75 percent; depth to rock.	Not needed	Slopes of 15 to 75 percent; slow permeability; moderate available water capacity.	D
Poor: low strength; high shrink-swell potential; slope in AcF and AcG.	Medium to low shear strength and susceptibility to piping; low permeability; medium compressibility; fair to good compaction characteristics.	Slopes of 9 to 75 percent.	Not needed	Slopes of 9 to 75 percent; slow permeability; moderately high to high available water capacity.	D
Poor: high shrink-swell potential; low strength in subsoil.	Medium to low shear strength and susceptibility to piping; medium compressibility; low permeability; fair to good compaction characteristics.	Slopes of 0 to 9 percent.	Very slow permeability; slopes of 0 to 9 percent.	Slopes of 0 to 9 percent; low to moderate available water capacity; shallow root depth; very slow permeability.	D
Poor: low strength	Medium to low shear strength and susceptibility to piping; medium compressibility; low permeability; fair to good compaction characteristics.	Slopes of 0 to 9 percent.	Moderately slow permeability; slopes of 0 to 9 percent.	Slopes of 0 to 9 percent; high available water capacity.	B
Poor: high shrink-swell potential; low strength.	Medium to low shear strength and susceptibility to piping; low permeability; medium compressibility; fair to good compaction characteristics.	Favorable	Moderately slow permeability.	Slopes of 0 to 2 percent; high available water capacity.	B
Poor: high shrink-swell potential; low strength.	Medium to low shear strength and susceptibility to piping; low permeability; medium compressibility; fair to good compaction characteristics.	Favorable	Moderately slow permeability; water table at a depth of 3½ to 4 feet.	Slopes of 0 to 2 percent; moderately high available water capacity; water table at a depth of 3½ to 4 feet.	C
Fair for BdE and BdE2: slope; medium strength. Poor for BdF and BdF2: slope.	Medium shear strength; medium to high susceptibility to piping; medium to low compressibility and permeability; fair to good compaction characteristics.	Slopes of 5 to 50 percent; rapid permeability; depth to bedrock.	Not needed	Slopes of 5 to 50 percent; low available water capacity.	B

TABLE 6.—*Engineering*

Soil series and map symbols	Degree and kind of limitations for—				Suitability as a source of—
	Local roads and streets	Septic tank filter fields	Dwellings without basement	Sanitary landfill (trench type)	Topsoil
Briones—Continued BeB	Moderate: medium strength.	Slight	Slight	Severe: moderately rapid permeability; lateral seepage.	Good: fine sandy loam.
Capay: CaA, CaC, CbA	Severe: low strength; high shrink-swell potential.	Severe: slow permeability; water table at a depth of 40 to 50 inches in CbA.	Severe: high shrink-swell potential; low strength.	Severe: clay; water table at a depth of 3½ to 4 feet in CbA.	Poor: clay
Clear Lake: Cc	Severe: low strength; high shrink-swell potential.	Severe: slow permeability.	Severe: high shrink-swell potential; low strength.	Severe: clay	Poor: clay
Conejo: CeA, CeB	Severe: low strength.	Severe: moderately slow permeability.	Moderate: moderate shrink-swell potential; low strength.	Moderate: clay loam.	Fair: clay loam
ChA	Severe: high shrink-swell potential below depth of 40 inches; low strength.	Severe: slow permeability below depth of 40 inches.	Moderate: moderate shrink-swell potential; high shrink-swell potential below depth of 40 inches; low strength.	Moderate: clay loam over clay.	Fair: clay loam
Cropley: CkB	Severe: high shrink-swell potential; low strength.	Severe: slow permeability.	Severe: high shrink-swell potential.	Severe: clay	Poor: clay
*Cut and fill land: CmE, CnE For interpretations of the Diablo part of CmE, see the Diablo series. For interpretations of the Los Osos part of CnE, see the Los Osos series.	Severe: high shrink-swell potential; medium to low strength.	Severe: variable depth to rock; moderately slow to slow permeability.	Severe: variable depth to rock; high shrink-swell potential.	Not applicable	Poor: clayey

See footnote at end of table.

interpretations—Continued

Suitability as a source of—Continued	Soil features affecting—				
Road fill	Water retention		Drainage for crops and pasture	Irrigation	Hydrologic soil group
	Embankments	Reservoir areas			
Fair: medium strength.	Medium shear strength; medium to low permeability; fair to good compaction characteristics; medium to high susceptibility to piping; low to medium compressibility.	Moderately rapid over moderately slow permeability.	Slopes of 2 to 5 percent.	Slopes of 2 to 5 percent; moderate available water capacity.	B
Poor: high shrink-swell potential; low strength.	Medium to low shear strength and susceptibility to piping; fair to good compaction characteristics; medium compressibility; low permeability of compacted soil.	Slopes of 0 to 9 percent.	Slow permeability; slopes of 0 to 9 percent; water table at a depth of 40 to 50 inches in CbA.	Slopes of 0 to 9 percent; slow permeability; moderately high to high available water capacity.	D
Poor: high shrink-swell potential; low strength.	Medium to low shear strength and susceptibility to piping; fair to good compaction characteristics; medium compressibility; low permeability.	Favorable	Slow permeability	Slow permeability; moderately high to high available water capacity.	D
Poor: low strength	Medium to low shear strength and susceptibility to piping; fair to good compaction characteristics; medium compressibility; low permeability of compacted soil.	Slopes of 0 to 5 percent.	Moderately slow permeability; slopes of 0 to 5 percent.	Moderately slow permeability; high available water capacity; slopes of 0 to 5 percent.	C
Poor: low strength; high shrink-swell potential below depth of 40 inches.	Medium to low shear strength and susceptibility to piping; fair to good compaction characteristics; medium compressibility; low permeability of compacted soil.	Favorable	Slow permeability below depth of 40 inches.	Slow permeability below depth of 40 inches; moderately high available water capacity.	D
Poor: high shrink-swell potential; low strength.	Medium to low shear strength and susceptibility to piping; fair to good compaction characteristics; medium compressibility; low permeability of compacted soil.	Slopes of 2 to 5 percent.	Slow permeability; slopes of 2 to 5 percent.	Slow permeability; moderately high to high available water capacity; slopes of 2 to 5 percent.	D
Not applicable	Medium to low shear strength and susceptibility to piping; low permeability; medium compressibility; fair to good compaction characteristics.	Not applicable	Variable depth to rock; moderately slow permeability.	Variable root depth and available water capacity; moderately slow to slow permeability.	D

TABLE 6.—*Engineering*

Soil series and map symbols	Degree and kind of limitations for—				Suitability as a source of—
	Local roads and streets	Septic tank filter fields	Dwellings without basement	Sanitary landfill (trench type)	Topsoil
Cut and fill land—Continued CoE, CoF For interpretations of the Millsholm part of CoE and CoF, see the Millsholm series.	Severe: slopes of 9 to 50 percent; depth to rock.	Severe: variable depth to rock; moderately slow to slow permeability.	Severe: variable depth to rock.	Not applicable	Poor: loamy with gravel.
Delhi: DaC	Slight	Slight	Slight	Severe: rapid permeability; sand.	Poor: sandy
Diablo: DdD, DdE, DdF	Severe: low strength; high shrink-swell potential; slope in DdE and DdF.	Severe: slow permeability; depth to rock; slope in DdE and DdF.	Severe: high shrink-swell potential; slope in DdE and DdF.	Severe: clay; depth to rock; slope in DdF.	Poor: clay; slope in DdE and DdF.
Dibble: DeE, DeF	Severe: low strength; high shrink-swell potential; slope.	Severe: slope; depth to rock; slow permeability.	Severe: slope; high shrink-swell potential.	Severe: depth to rock; clay; slope in DeF.	Poor: silty clay loam over clay; slope.
Egbert: Eg	Severe: very poorly drained.	Severe: water table at depth of 1½ to 4 feet; slow permeability.	Severe: very poorly drained; high shrink-swell potential.	Severe: very poorly drained; mucky clay loam.	Poor: very poorly drained; mucky clay loam.
Felton: FaG	Severe: slope	Severe: slope; moderately slow permeability.	Severe: slope	Severe: slope; depth to rock.	Poor: slope
Fluvaquents: Fc. Properties are too variable for interpretations to be made.					
*Fontana: Fd For interpretations of the Altamont part, see the Altamont series.	Severe: slope	Severe: moderately slow permeability; slope; depth to rock.	Severe: slope	Severe: depth to rock; slope in Fontana part of AcF and AcG.	Poor: slope

See footnote at end of table.

interpretations—Continued

Suitability as a source of—Continued	Soil features affecting—				Hydrologic soil group
Road fill	Water retention		Drainage for crops and pasture	Irrigation	
	Embankments	Reservoir areas			
Not applicable	Medium to low shear strength, susceptibility to piping, and compressibility; low permeability; good to fair compaction characteristics.	Not applicable	Variable depth to rock; moderately slow to slow permeability.	Variable depth to rock; low available water capacity; moderately slow to slow permeability.	D
Good	Medium shear strength; low compressibility; high permeability of compacted soil; medium to high susceptibility to piping; good compaction characteristics.	Rapid permeability	Not needed	Rapid permeability; low available water capacity.	A
Poor: low strength; high shrink-swell potential; slope in DdF.	Medium to low shear strength and susceptibility to piping; fair to good compaction characteristics; low permeability of compacted soil; medium compressibility.	Slopes of 9 to 50 percent; depth to rock.	Not needed	Slow permeability; slopes of 9 to 50 percent; moderate to moderately high available water capacity; depth to rock.	D
Poor: high shrink-swell potential; low strength; slope in DeF.	Medium to low shear strength and susceptibility to piping; low permeability; medium compressibility; fair to good compaction characteristics.	Slow permeability; slopes of 15 to 50 percent.	Not needed	Slopes of 15 to 50 percent; moderately deep root zone; moderate available water capacity; slow permeability.	C
Poor: very poorly drained; low strength; high shrink-swell potential.	Low shear strength; high compressibility; low to medium permeability; medium to high susceptibility to piping; fair to poor compaction characteristics.	Water table at depth of 1½ to 4 feet.	Water table at depth of 1½ to 4 feet; slow permeability.	Slow permeability; moderate to moderately high available water capacity; water table at depth of 1½ to 4 feet.	D
Poor: slope	Medium to low shear strength, compressibility, and susceptibility to piping; low permeability; good to fair compaction characteristics.	Depth of rock; slope	Not needed	Slopes of 50 to 75 percent; moderately slow permeability; deep root zone; moderate available water capacity.	B
Poor: depth to rock; slope in Fontana part of AcF and AcG.	Medium to low shear strength and susceptibility to piping; medium compressibility; low permeability; fair to good compaction characteristics.	Slopes of 9 to 30 percent; depth to rock.	Not needed	Slopes of 9 to 30 percent; moderately slow permeability; moderate available water capacity.	B

TABLE 6.—*Engineering*

Soil series and map symbols	Degree and kind of limitations for—				Suitability as a source of—
	Local roads and streets	Septic tank filter fields	Dwellings without basement	Sanitary landfill (trench type)	Topsoil
Garretson: GaA, GaB	Moderate: medium strength.	Slight to moderate: moderate permeability.	Moderate: medium strength.	Slight	Good
Gaviota: GbE, GbF, GbG	Severe: slope; depth to rock.	Severe: slope; depth to rock.	Severe: slope; depth to rock.	Severe: depth to rock; slope in GbF and GbG.	Poor: depth to rock; slope.
Gilroy: GcE, GcF, GcG	Severe: slope; low strength.	Severe: slope; depth to rock; moderately slow permeability.	Severe: slope	Severe: depth to rock; slope in GcF and GcG.	Poor: slope
Joice: Ja	Severe: Pt material; very poorly drained.	Severe: subject to tidal inundation; water table at depth of 1 to 3 feet.	Severe: very poorly drained; muck; Pt material; high shrink-swell potential.	Severe: very poorly drained; muck.	Poor: very poorly drained; muck.
Kimball: KaC, KaE	Severe: high shrink-swell potential; low strength.	Severe: very slow permeability; slope in KaE.	Severe: high shrink-swell potential in subsoil; slope in KaE.	Severe: clay subsoil.	Poor: gravelly clay loam over clay; slope in KaE.
Kingile: Kb	Severe: very poorly drained; high shrink-swell potential below depth of 20 inches; very low strength.	Severe: water table at depth of 1 to 5 feet; slow permeability.	Severe: very poorly drained; high shrink-swell potential below depth of 20 inches; muck over silty clay.	Severe: very poorly drained; muck over silty clay.	Poor: very poorly drained; muck over silty clay.
Laugenour: La	Moderate: medium strength.	Moderate: water table below depth of 5 feet.	Moderate: medium strength.	Severe: rapid permeability below depth of 30 inches.	Fair: loam and silty clay loam.

See footnote at end of table.

interpretations—Continued

Suitability as a source of—Continued	Soil features affecting—				
	Water retention		Drainage for crops and pasture	Irrigation	Hydrologic soil group
Road fill	Embankments	Reservoir areas			
Fair: medium strength.	Medium to low shear strength and permeability of compacted soil; low compressibility; high susceptibility to piping; poor compaction characteristics.	Slopes of 0 to 5 percent; moderate permeability.	Not needed	Moderate permeability; high available water capacity.	B
Poor: depth to rock; slope in GbF and GbG.	Low to medium compressibility and permeability of compacted soil; medium shear strength; medium to high susceptibility to piping; fair to good compaction characteristics.	Slopes of 15 to 75 percent; depth to rock.	Not needed	Slopes of 15 to 75 percent; shallow root zone; low available water capacity; moderately rapid permeability.	D
Poor: depth to rock; low strength; slope in GcF and GcG.	Low to medium shear strength and susceptibility to piping; medium compressibility; low permeability of compacted soil; fair to good compaction characteristics.	Slopes of 15 to 75 percent; depth to rock.	Not needed	Slopes of 15 to 75 percent; moderate available water capacity; moderately slow permeability.	C
Poor: very poorly drained.	Not suitable for use in embankments; Pt material.	Very poorly drained; moderate permeability.	Water table at depth of 1 to 3 feet; moderate permeability.	Moderate permeability; acid, organic soil; water table at depth of 1 to 3 feet.	D
Poor: high shrink-swell potential; low strength.	Medium to low shear strength, susceptibility to piping, and compressibility; low permeability of compacted soil; fair to good compaction characteristics.	Slopes of 2 to 30 percent.	Very slow permeability; slopes of 2 to 30 percent.	Slopes of 2 to 30 percent; shallow root zone; low to moderate available water capacity.	C
Poor: very poorly drained; high shrink-swell potential below depth of 20 inches; very low strength.	Not suitable for use in embankments; classified as Pt over OL or CL.	Very poorly drained	Rapid over slow permeability; water table at depth of 1 to 5 feet.	Rapid over slow permeability; moderate to high available water capacity; water table at depth of 1 to 5 feet.	D
Fair: medium strength.	Medium to low shear strength, permeability of soil, susceptibility to piping, and compressibility; fair to good compaction characteristics.	Rapid permeability below depth of 30 inches.	Water table below depth of 5 feet.	Rapid permeability below depth of 30 inches; moderate available water capacity; water table below depth of 5 feet.	B

TABLE 6.—*Engineering*

Soil series and map symbols	Degree and kind of limitations for—				Suitability as a source of—
	Local roads and streets	Septic tank filter fields	Dwellings without basement	Sanitary landfill (trench type)	Topsoil
Linne: LbD, LbE	Severe: low strength; slope in LbE.	Severe: moderately slow permeability; depth to rock; slope in LbE.	Moderate for LbD: low strength; moderate shrink-swell potential. Severe for LbE: slope.	Severe: depth to rock.	Fair for LbD: clay loam. Poor for LbE: slope.
Lodo: LcE, LcF, LcG, Ld. Properties of the Rock outcrop part of Ld are too variable for interpretations to be made.	Severe: slope; depth to rock; low strength.	Severe: moderately slow permeability; depth to rock; slope.	Severe: slope; depth to rock.	Severe: depth to rock; slope in LcF, LcG, and Ld.	Poor: slope; thin layer.
Los Gatos: LeE, LeF, LeG	Severe: slope	Severe: slope; moderately slow permeability; depth to rock.	Severe: slope	Severe: depth to rock; slope in LeF and LeG.	Poor: slope; loam over clay loam.
*Los Osos: LhE, LhF, LhG, Lk. For interpretations of the Los Gatos part of Lk, see the Los Gatos series.	Severe: slope; low strength; high shrink-swell potential.	Severe: slope; slow permeability; depth to rock.	Severe: slope; high shrink-swell potential.	Severe: clay; depth to rock; slope in LhF, LhG, and Lk.	Poor: slope; clay loam over clay.
Los Robles: Lm	Moderate: medium strength; moderate shrink-swell potential.	Severe: moderately slow permeability.	Moderate: moderate shrink-swell potential.	Slight	Fair: clay loam
Marcuse: Ma	Severe: poorly drained; high shrink-swell potential below depth of 20 inches; low strength.	Severe: slow permeability; water table at depth of 3½ to 4 feet.	Severe: poorly drained; high shrink-swell potential below depth of 20 inches.	Severe: water table at depth of 3½ to 4 feet; sand over clay.	Poor: sand over clay.

See footnote at end of table.

interpretations—Continued

Suitability as a source of—Continued	Soil features affecting—				
Road fill	Water retention		Drainage for crops and pasture	Irrigation	Hydrologic soil group
	Embankments	Reservoir areas			
Poor: low strength	Medium to low shear strength and susceptibility to piping; medium compressibility; low permeability of compacted soil; fair to good compaction characteristics.	Depth to rock; slopes of 5 to 30 percent.	Moderately slow permeability; slopes of 5 to 30 percent.	Slopes of 5 to 30 percent; moderately deep root zone; moderately slow permeability; moderate to moderately high available water capacity.	C
Poor: thin layer; low strength; slope in LcF, LcG, and Ld.	Medium to low shear strength and susceptibility to piping; medium compressibility; low permeability of compacted soil; fair to good compaction characteristics.	Slopes of 9 to 75 percent; depth to rock.	Not needed	Slopes of 9 to 75 percent; shallow root zone; low available water capacity; moderately slow permeability.	D
Poor: thin layer; slope in LeF and LeG.	Medium to low shear strength; medium compressibility; medium to low permeability of compacted soil; low to high susceptibility to piping; fair to good compaction characteristics.	Slopes of 15 to 75 percent; depth to rock.	Not needed	Slopes of 15 to 75 percent; moderately deep root zone; moderate available water capacity; slow permeability.	C
Poor: low strength; high shrink-swell potential; slope in LhF, LhG, and Lk.	Medium to low shear strength and susceptibility to piping; medium compressibility; low permeability of compacted soil; fair to good compaction characteristics.	Slopes of 15 to 75 percent; depth to rock.	Not needed	Slopes of 15 to 75 percent; moderately deep root zone; moderate available water capacity; slow permeability.	C
Fair: medium strength; moderate shrink-swell potential.	Medium to low shear strength and susceptibility to piping; medium compressibility; low permeability of compacted soil; fair to good compaction characteristics.	Favorable	Not needed	High available water capacity; very deep root zone; moderately slow permeability.	B
Poor: poorly drained; high shrink-swell potential below depth of 20 inches; low strength.	Medium to low shear strength and susceptibility to piping; medium compressibility; low permeability of compacted soil; fair to good compaction characteristics. These features affect the CL part of the profile. The sand surface layer was not evaluated because of the thickness.	Water table at depth of 3½ to 4 feet.	Water table at depth of 3½ to 4 feet; slow permeability.	Sandy surface layer; slow permeability below depth of 20 inches; moderate available water capacity; water table at depth of 3½ to 4 feet.	D

TABLE 6.—*Engineering*

Soil series and map symbols	Degree and kind of limitations for—				Suitability as a source of—
	Local roads and streets	Septic tank filter fields	Dwellings without basement	Sanitary landfill (trench type)	Topsoil
Marcuse—Continued Mb, Mc	Severe: poorly drained; high shrink-swell potential; low strength.	Severe: slow permeability; water table at depth of 3½ to 4 feet.	Severe: poorly drained; high shrink-swell potential.	Severe: water table at depth of 3½ to 4 feet; clay.	Poor: clay
Merritt: Md	Severe: poorly drained.	Severe: water table at depth of 3½ to 5 feet.	Moderate: medium to low strength.	Severe: water table at depth of 3½ to 5 feet.	Poor: poorly drained.
Millsholm: MeE, MeF, MeG	Severe: depth to rock; slope.	Severe: slopes of 15 to 75 percent; depth to rock.	Severe: slope	Severe: depth to rock; slope in MeF and MeG.	Poor: slope; thin layer.
Omni: Oa, Ob	Severe: poorly drained; high shrink-swell potential; low strength.	Severe: slow permeability; water table at depth of 2½ to 4 feet.	Severe: poorly drained; high shrink-swell potential.	Severe: water table at depth of 2½ to 4 feet; clay loam, clay, and silty clay.	Poor: poorly drained; clay loam, clay, and silty clay.
Perkins: PaC, PaD	Moderate: moderate shrink-swell potential; medium strength; slope in PaD.	Severe: slow permeability; weakly consolidated layer at depth of 40 to 60 inches.	Moderate: moderate shrink-swell potential; slope in PaD.	Slight	Poor: gravelly loam and gravelly clay loam.
Pescadero: Pb, Pc	Severe: poorly drained; high shrink-swell potential; low strength.	Severe: slow permeability; water table at depth of 4 to 5 feet or more.	Severe: high shrink-swell potential.	Severe: water table at depth of 4 to 5 feet or more; clay.	Poor: clay; strongly alkaline.

See footnote at end of table.

interpretations—Continued

Suitability as a source of—Continued	Soil features affecting—				
	Water retention		Drainage for crops and pasture	Irrigation	Hydrologic soil group
Road fill	Embankments	Reservoir areas			
Poor: poorly drained; high shrink-swell potential; low strength.	Medium to low shear strength and susceptibility to piping; medium compressibility; low permeability of compacted soil; fair to good compaction characteristics.	Water table at depth of 3½ to 4 feet.	Water table at depth of 3½ to 4 feet; slow permeability; high exchangeable sodium.	Slow permeability; high exchangeable sodium; water table at depth of 3½ to 4 feet.	D
Poor: poorly drained	Mostly medium to low shear strength and permeability of compacted soil; medium compressibility; high susceptibility to piping; fair to poor compaction characteristics.	Moderate permeability; water table at depth of 3½ to 5 feet.	Moderate permeability; water table at depth of 3½ to 5 feet.	Moderate to moderately high available water capacity; deep root zone; moderate permeability; water table at depth of 3½ to 5 feet.	D
Poor: thin layer; slope in MeF and MeG.	Medium to low shear strength and permeability of compacted soil; medium compressibility; high susceptibility to piping; fair to poor compaction characteristics.	Depth to rock; slopes of 15 to 75 percent.	Not needed	Slopes of 15 to 75 percent; shallow root zone; low available water capacity; moderate permeability.	D
Poor: poorly drained; high shrink-swell potential; low strength.	Medium to low shear strength and susceptibility to piping; low permeability of compacted soil; medium compressibility; fair to good compaction characteristics.	Water table at depth of 2½ to 4 feet.	Slow permeability; water table at depth of 2½ to 4 feet.	Slow permeability; moderate to moderately high available water capacity; water table at depth of 2½ to 4 feet.	D
Fair: medium strength; moderate shrink-swell potential.	Medium to low shear strength and susceptibility to piping; low permeability of compacted soil; medium compressibility; fair to good compaction characteristics.	Slopes of 2 to 15 percent.	Weakly consolidated, slowly permeable layer at depth of 40 inches; slopes of 2 to 15 percent.	Slopes of 2 to 15 percent; slow permeability; moderately deep root zone; moderate available water capacity.	C
Poor: poorly drained; high shrink-swell potential; low strength.	Medium to low shear strength and susceptibility to piping; low permeability of compacted soil; medium compressibility; fair to good compaction characteristics.	Water table at depth of 4 to 5 feet or more.	Slow permeability; water table at depth of 4 to 5 feet or more.	Highly alkaline; slow permeability; moderate to moderately high available water capacity; water table at depth of 4 to 5 feet or more.	D

TABLE 6.—*Engineering*

Soil series and map symbols	Degree and kind of limitations for—				Suitability as a source of—
	Local roads and streets	Septic tank filter fields	Dwellings without basement	Sanitary landfill (trench type)	Topsoil
Piper: Pd, Pe	Severe: poorly drained.	Severe: poorly drained; water table at depth of 2½ to 4 feet.	Severe: poorly drained.	Severe: water table at depth of 2½ to 4 feet; rapid permeability.	Poor: poorly drained; sand and loamy sand.
Ph	Severe: poorly drained.	Severe: poorly drained; water table at depth of 1½ to 3 feet.	Severe: poorly drained.	Severe: water table at depth of 1½ to 3 feet; rapid permeability below depth of 38 inches.	Poor: poorly drained.
Positas: PkA, PkC	Severe: high shrink-swell potential; low strength.	Severe: very slow permeability.	Severe: high shrink-swell potential in subsoil.	Severe: clay subsoil.	Fair: loam over clay.
Quarry: Qa. Not applicable.					
Reyes: Ra	Severe: very poorly drained; high shrink-swell potential; low strength; clayey and organic.	Severe: water table at depth of ½ to 2 feet; slow permeability.	Severe: very poorly drained; high shrink-swell potential; low strength.	Severe: water table at depth of ½ to 2 feet; clayey and organic.	Poor: very poorly drained; clayey and organic.
Rincon: RbA, RbC, RbD	Severe: high shrink-swell potential; low strength.	Severe: slow permeability.	Severe: high shrink-swell potential; low strength.	Severe: clay subsoil.	Fair: clay loam over clay; slope in RbD.
RcA	Severe: high shrink-swell potential; low strength; high water table.	Severe: slow permeability; water table at depth of 3½ to 4½ feet.	Severe: high shrink-swell potential; low strength.	Severe: clay subsoil; water table at depth of 3½ to 4½ feet.	Fair: clay loam over clay.

See footnote at end of table.

interpretations—Continued

Suitability as a source of—Continued	Soil features affecting—				Hydrologic soil group
Road fill	Water retention		Drainage for crops and pasture	Irrigation	
	Embankments	Reservoir areas			
Poor: poorly drained.	Medium shear strength; low to medium compressibility and permeability of compacted soil; medium to high susceptibility to piping; fair to good compaction characteristics.	Rapid permeability; water table at depth of 2½ to 4 feet.	Water table at depth of 2½ to 4 feet; rapid permeability.	Low available water capacity; rapid permeability; water table at depth of 2½ to 4 feet; susceptible to soil blowing.	C
Poor: poorly drained.	Medium shear strength; low to medium compressibility and permeability of compacted soil; medium to high susceptibility to piping; fair to good compaction characteristics.	Rapid permeability below depth of 38 inches; water table at depth of 1½ to 3 feet.	Water table at depth of 1½ to 3 feet; rapid permeability.	Low to moderate available water capacity; rapid permeability below depth of 38 inches; susceptible to soil blowing; water table at depth of 1½ to 3 feet.	C
Poor: high shrink-swell potential; low strength.	Mostly medium to low shear strength and susceptibility to piping; medium compressibility; low permeability; fair to good compaction characteristics.	Slopes of 0 to 9 percent.	Slopes of 0 to 9 percent; very slow permeability.	Shallow root depth; slopes of 0 to 9 percent; very slow permeability; low to moderate available water capacity.	D
Poor: very poorly drained; high shrink-swell potential; low strength; clayey and organic.	Suitable for low embankments with low hazard only; low shear strength and permeability of compacted soil; high compressibility; medium to low susceptibility to piping; poor compaction characteristics.	Water table at depth of ½ to 2 feet.	Water table at depth of ½ to 2 feet; soil becomes acid when drained; slow permeability.	Water table at depth of ½ to 2 feet; highly saline soil becomes acid when drained; low available water capacity; slow permeability.	D
Poor: high shrink-swell potential; low strength.	Medium to low shear strength and susceptibility to piping; low permeability of compacted soil; medium compressibility; fair to good compaction characteristics.	Slopes of 0 to 15 percent.	Slopes of 0 to 15 percent; slow permeability.	Slow permeability; very deep root zone; slopes of 0 to 15 percent; moderately high to high available water capacity.	C
Poor: high shrink-swell potential; low strength.	Medium to low shear strength and susceptibility to piping; low permeability of compacted soil; medium compressibility; fair to good compaction characteristics.	Slopes of 0 to 15 percent.	Slopes of 0 to 15 percent; slow permeability; water table at depth of 3½ to 4½ feet.	Slow permeability; very deep root zone; slopes of 0 to 15 percent; moderately high available water capacity; water table at depth of 3½ to 4½ feet.	D

TABLE 6.—*Engineering*

Soil series and map symbols	Degree and kind of limitations for—				Suitability as a source of—
	Local roads and streets	Septic tank filter fields	Dwellings without basement	Sanitary landfill (trench type)	Topsoil
Rindge: Rd	Severe: very poorly drained; organic material.	Severe: water table at depth of 1 to 4 feet.	Severe: very poorly drained; organic material; high shrink, low swell.	Severe: very poorly drained; organic material.	Poor: very poorly drained; muck.
Rock outcrop: Re	Severe: very shallow to bedrock; slope.	Severe: very shallow to bedrock; slope.	Severe: very shallow to bedrock; slope.	Severe: very shallow to bedrock; slope.	Poor: very shallow to bedrock; slope.
Ryde: Rh	Severe: very poorly drained; low strength.	Severe: water table at depth of 3½ to 4 feet.	Severe: very poorly drained; low strength.	Severe: water table at depth of 3½ to 4 feet.	Poor: very poorly drained.
Sacramento: Sa, Sb	Severe: very poorly drained; high shrink-swell potential; low strength.	Severe: slow permeability; water table at depth of 4 to 5 feet.	Severe: high shrink-swell potential; poorly drained; low strength.	Severe: water table at depth of 4 to 5 feet; clay.	Poor: poorly drained; clay.
San Ysidro: Sc	Severe: high shrink-swell potential; low strength.	Severe: very slow permeability.	Severe: high shrink-swell potential.	Severe: clay and silty clay subsoil.	Fair: thin layer; loam over clay and silty clay.
Sehorn: SdE, SdF, SdG	Severe: high shrink-swell potential; slope; low strength.	Severe: slow permeability; depth to rock; slope.	Severe: high shrink-swell potential; slope.	Severe: clay; depth to rock; slope in SdF and SdG.	Poor: clay; slope.
Shima: Se	Severe: very poorly drained; muck (Pt) surface layer.	Severe: water table at depth of 2 to 4 feet.	Severe: very poorly drained; soil susceptible to settlement.	Severe: muck over sand; water table at depth of 2 to 4 feet; rapid permeability.	Poor: very poorly drained; muck over sand.

See footnote at end of table.

interpretations—Continued

Suitability as a source of—Continued	Soil features affecting—				Hydrologic soil group
Road fill	Water retention		Drainage for crops and pasture	Irrigation	
	Embankments	Reservoir areas			
Poor: very poorly drained; organic material.	Not suitable for embankments; organic material.	Very poorly drained; rapid permeability.	Water table at depth of 1 to 4 feet; rapid permeability.	Rapid permeability; susceptible to soil blowing; organic material; water table at depth of 1 to 4 feet.	D
Poor: very shallow to bedrock; slope.	Thin layer; medium to low shear strength; medium compressibility; high susceptibility to piping; fair to poor compaction characteristics.	Very shallow to bedrock; slope.	Not needed	Not needed	D
Poor: very poorly drained; low strength.	Suitable for low embankments with very low hazards; low to medium shear strength and permeability; high to medium compressibility; high to medium susceptibility to piping; fair to poor compaction.	Moderate permeability; water table at depth of 3½ to 4 feet.	Water table at depth of 3½ to 4 feet; moderate permeability.	Water table at depth of 3½ to 4 feet; susceptible to soil blowing; moderate to moderately high available water capacity; deep root zone; moderate permeability.	D
Poor: poorly drained; high shrink-swell potential; low strength.	Low to medium shear strength, permeability, and susceptibility to piping; high compressibility; poor to fair compaction characteristics.	Water table at depth of 4 to 5 feet.	Poorly drained; slow permeability; water table at depth of 4 to 5 feet.	Slow permeability; moderate to moderately high available water capacity; deep root zone; water table at depth of 4 to 5 feet; Sb is saline and alkali.	D
Poor: high shrink-swell potential; low strength.	Medium to low shear strength; low permeability and susceptibility to piping; high compressibility; fair to poor compaction characteristics.	Favorable	Very slow permeability.	Very slow permeability; shallow root depth; low to moderate available water capacity.	D
Poor: high shrink-swell potential; low strength; thin layer in SdE; slope in SdF and SdG.	Medium to low shear strength and susceptibility to piping; medium compressibility; low permeability of compacted soil; fair to good compaction characteristics.	Slopes of 15 to 75 percent; depth to rock.	Not needed	Slopes of 15 to 75 percent; slow permeability; moderate available water capacity moderately deep root zone.	D
Poor: very poorly drained; muck (Pt) surface layer.	Surface layer classified as Pt; not suitable for embankments; the sand layer has medium shear strength; low to medium compressibility; low to high permeability; medium to high susceptibility to piping; good to fair compaction characteristics.	Rapid permeability; water table at depth of 2 to 4 feet.	Water table at depth of 2 to 4 feet; rapid permeability.	Water table at depth of 2 to 4 feet; rapid permeability; susceptible to soil blowing; moderate to high available water capacity.	D

TABLE 6.—*Engineering*

Soil series and map symbols	Degree and kind of limitations for—				Suitability as a source of—
	Local roads and streets	Septic tank filter fields	Dwellings without basement	Sanitary landfill (trench type)	Topsoil
Solano: Sh, Sk	Severe: high shrink-swell potential; low strength.	Severe: very slow permeability.	Severe: high shrink-swell potential.	Moderate: somewhat poorly drained clay loam and silty clay loam subsoil.	Poor: high exchangeable sodium.
Sorrento: Sm	Moderate: moderate shrink-swell potential; medium strength.	Severe: moderately slow permeability.	Moderate: moderate shrink-swell potential.	Moderate: silty clay loam.	Fair: silty clay loam.
Sn	Moderate: medium strength; low shrink-swell potential below depth of 40 inches.	Slight if tile placed below depth of 40 inches.	Moderate: moderate shrink-swell potential.	Severe: silty clay loam over sand; rapid permeability below depth of 40 inches.	Fair: silty clay loam; sand below depth of 40 inches.
Sycamore: So	Severe: poorly drained.	Severe: water table at depth of 3½ to 5 feet; moderately slow permeability.	Moderate: moderate shrink-swell potential; medium strength.	Severe: water table at depth of 3½ to 5 feet.	Fair: silty clay loam.
Sp	Severe: poorly drained; high shrink-swell potential and low strength below depth of 40 inches.	Severe: water table at depth of 3½ to 5 feet; slow permeability below depth of 40 inches.	Severe: high shrink-swell potential and low strength below depth of 40 inches.	Severe: water table at depth of 3½ to 5 feet; clay below depth of 40 inches.	Fair: silty clay loam over clay.
Tierra: TaC, TaD, TaE	Severe: high shrink-swell potential and low strength in subsoil; slope in TaE.	Severe: very slow permeability; slope in TaE.	Severe: high shrink-swell potential; slope in TaE.	Poor: clay subsoil.	Fair for TaC: loam and clay loam over clay. Fair for TaD: loam and clay loam over clay; slope. Poor for TaE: slope.

See footnote at end of table.

interpretations—Continued

Suitability as a source of—Continued	Soil features affecting—				
Road fill	Water retention		Drainage for crops and pasture	Irrigation	Hydrologic soil group
	Embankments	Reservoir areas			
Poor: high shrink-swell potential; low strength.	Medium to low shear strength and susceptibility to piping; medium compressibility; low permeability of compacted soil; fair to good compaction characteristics.	Water table at depth of 3 to 4 feet.	Water table at depth of 3 to 4 feet; high exchangeable sodium; very slow permeability.	Very slow permeability; high exchangeable sodium; moderate available water capacity.	D
Fair: moderate shrink-swell potential; medium strength.	Medium to low shear strength and susceptibility to piping; medium compressibility; low permeability of compacted soil; fair to good compaction characteristics.	Favorable	Not needed	High available water capacity; very deep root zone; moderately slow permeability.	B
Fair: medium strength; low shrink-swell potential below depth of 40 inches.	Medium to low shear strength and susceptibility to piping; medium compressibility; low permeability of compacted soil; fair to good compaction characteristics; sand below depth of 40 inches.	Rapid permeability below depth of 40 inches.	Not needed	Moderate to moderately high available water capacity; very deep root zone; rapid permeability below depth of 40 inches.	B
Poor: poorly drained	Medium to low shear strength and permeability of compacted soil; medium compressibility; high to low susceptibility to piping; good to poor compaction characteristics.	Water table at depth of 3½ to 5 feet.	Water table at depth of 3½ to 5 feet; moderately slow permeability.	Moderately high to high available water capacity; deep root zone; water table at depth of 3½ to 5 feet; moderately slow permeability.	C
Poor: poorly drained; high shrink-swell potential and low strength below depth of 40 inches.	Medium to low shear strength and permeability of compacted soil; medium compressibility; high to low susceptibility to piping; good to poor compaction characteristics.	Water table at depth of 3½ to 5 feet.	Water table at depth of 3½ to 5 feet; slow permeability below depth of 40 inches.	Moderately high to high available water capacity; deep root zone; water table at depth of 3½ to 5 feet, moderately slow permeability; slow permeability below depth of 40 inches.	C
Poor: high shrink-swell potential and low strength in subsoil.	Mostly medium to low shear strength and susceptibility to piping; medium compressibility; low permeability; fair to good compaction characteristics.	Slopes of 2 to 30 percent.	Slopes of 2 to 30 percent.	Slopes of 2 to 30 percent; moderately deep root zone; low to moderate available water capacity; very slow permeability.	D

TABLE 6.—*Engineering*

Soil series and map symbols	Degree and kind of limitations for—				Suitability as a source of—
	Local roads and streets	Septic tank filter fields	Dwellings without basement	Sanitary landfill (trench type)	Topsoil
Urban land: Ub. Properties are too variable for interpretations to be made.					
Vallecitos: VaF	Severe: slope; depth to rock; high shrink-swell potential and low strength in subsoil.	Severe: depth to rock; slope; slow permeability.	Severe: slope; depth to rock; high shrink-swell potential in subsoil.	Severe: slope; depth to rock.	Poor: slope; thin layer.
Venice: Vb	Severe: very poorly drained.	Severe: water table at depth of 2 to 4 feet.	Severe: very poorly drained; muck; Pt material; high shrink, low swell.	Severe: very poorly drained; muck.	Poor: very poorly drained; muck.
Webile: Wa	Severe: very poorly drained; Pt material.	Severe: water table at depth of 3 to 5 feet; slow permeability below depth of 40 inches.	Severe: very poorly drained; muck; Pt material; high shrink, low swell to depth of 40 inches; high shrink-swell potential below depth of 40 inches.	Severe: very poorly drained; muck over clay.	Poor: very poorly drained; muck over clay.
Zamora: ZaA, ZaB	Moderate: moderate shrink-swell potential; medium strength.	Severe: moderately slow permeability.	Moderate: moderate shrink-swell potential; medium strength.	Moderate: silty clay loam.	Fair: silty clay loam.

[1] Ground water contamination can be a hazard because of rapid permeability.

interpretations—Continued

Suitability as a source of—Continued	Soil features affecting—				
Road fill	Water retention		Drainage for crops and pasture	Irrigation	Hydrologic soil group
	Embankments	Reservoir areas			
Poor: slope; depth to rock; high shrink-swell potential and low strength in subsoil.	ML material: medium to low shear strength and permeability of compacted soil; medium compressibility; high susceptibility to piping; fair to poor compaction characteristics. CL material: medium to low shear strength and susceptibility to piping; medium compressibility; low permeability of compacted soil; fair to good compaction characteristics.	Slopes of 30 to 50 percent; depth to rock.	Not needed	Slopes of 30 to 50 percent; shallow root zone; low available water capacity; slow permeability.	D
Poor: Pt material; very poorly drained.	Not suitable for embankments; Pt material.	Very poorly drained; rapid permeability.	Water table at depth of 2 to 4 feet; rapid permeability; muck; subject to high water table.	Moderately high to high available water capacity; susceptible to soil blowing; rapid permeability; high water table.	D
Poor: Pt material; very poorly drained.	Not suitable for embankments; Pt material.	Very poorly drained; slow permeability below depth of 40 inches.	Water table at depth of 3 to 5 feet; slow permeability below depth of 40 inches; muck over clay.	Moderately high to high available water capacity; susceptible to soil blowing; slow permeability below depth of 40 inches.	D
Fair: moderate shrink-swell potential; medium strength.	Medium to low shear strength and permeability; medium compressibility; low to high susceptibility to piping; poor to good compaction characteristics.	Slopes of 0 to 5 percent.	Not needed	High available water capacity; very deep root zone; slopes of 0 to 5 percent; moderately slow permeability.	B

TABLE 7.—*Engineering*

[Tests performed by the California Division of Highways according to standard procedures

Soil name and location	Parent material	Report no.	Depth	Moisture-density data [1]		Mechanical analysis [2]		
						Percentage passing sieve—		
				Maximum dry density	Optimum moisture	¾ in	⅜ in	No. 4 (4.7 mm)
			Inches	*Pounds per cubic foot*	*Percent*			
Alo clay:								
2½ miles east of Alamo, NW¼NW¼ SW¼ sec. 16, T. 1 S., R. 1 W.	Soft, massive, fine-grained sandstone.	68–1282	0–6	107	16			
		68–1283	6–24	110	14			100
Botella clay loam:								
2,000 feet east of intersection of Norris Canyon Road and old State Highway 21.	Fine-textured alluvium from sedimentary rock.	68–1273	8–23	116	12			
		68–1274	52–68	125	10			
Brentwood clay loam:								
NE¼NE¼SE¼ sec. 24, T. 1 N., R. 2 E.	Fine-textured alluvium from sedimentary rock.	68–1268	0–8	117	12			
		68–1269	18–33	119	8			
		68–1270	50–60	118	12			
Kimball clay loam:								
SE¼SE¼NW¼NW¼ sec. 14, T. 1 N., R. 2 E.	Semiconsolidated gravelly sandy clay terrace material from mixed sources.	68–1280	15–26	116	14			
		68–1281	45–52	132	7	100	88	75
Los Osos clay loam:								
2 miles south of Lafayette, NE¼SW¼ SE¼ sec. 7, T. 1 S., R. 2 E.	Soft shale and fine-grained sandstone.	68–1278	0–9	115	11		100	99
		68–1279	20–32	117	11			100
Pescadero loam:								
1.3 miles north of Alameda-Contra Costa County Line on old State Highway 21, and 4,600 feet east of the old highway.	Fine-textured alluvium.	68–1271	5–21	116	10			
		68–1272	47–66	127	8		100	98
Tierra loam:								
2,600 feet west of old State Highway 21 on Norris Canyon Road, and 700 feet south of Norris Canyon Road, NE¼NE¼NW¼ sec. 16, T. 2 S., R. 1 W.	Semiconsolidated terrace material from predominantly sedimentary rock.	68–1275	4–13	121	10			
		68–1276	25–42	114	12			100
		68–1277	59–71	126				100

[1] Based on AASHTO Designation T 99–57, Method A (*1*) and California Division of Highways test method 216E.

[2] Mechanical analyses according to AASHTO Designation T 88 (*1*). Results by this procedure frequently differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser

test data

of the American Association of State Highway and Transportation Officials (AASHTO) (*1*)]

Mechanical analysis [2]—Continued								Liquid limit	Plasticity index	Classification	
Percentage passing sieve—Continued				Percentage smaller than—							
No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 60 (0.25 mm)	No. 200 (0.074 mm)	0.05 mm	0.02 mm	0.005 mm	0.002 mm			AASHTO [3]	Unified [4]
100	96	94	76	74	52	35	23	46	26	A–7–6	CL
98	94	90	75	73	54	38	25	48	28	A–7–6	CL
100	98	96	81	78	56	38	30	38	20	A–6	CL
100	94	86	55	51	33	19	13	30	16	A–6	CL
100	99	98	88	87	56	35	21	32	13	A–6	CL
---	100	99	91	88	56	41	27	36	18	A–6	CL
---	100	98	83	78	56	48	26	31	18	A–6	CL
100	91	88	82	80	52	37	26	43	27	A–7–6	CL
66	43	36	27	26	23	16	11	49	30	A–7–6	SC
90	78	74	65	62	40	26	16	46	23	A–7–6	CL
94	83	80	72	70	52	33	22	48	23	A–7–6	CL
100	99	97	85	81	57	41	32	39	25	A–6	CL
97	93	88	52	48	30	21	15	27	11	A–6	CL
100	90	84	65	62	38	25	18	26	12	A–6	CL
98	95	89	73	70	48	39	34	42	27	A–7–6	CL
94	83	72	48	46	31	20	15	29	14	A–6	SC

than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soils.

[3] Based on AASHTO Designation M 145–49 (*1*).

[4] Based on the Unified soil classification system (2).

fication are defined in the Glossary at the back of this survey.

Unified and AASHTO classifications are discussed in the preceding section.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a semisolid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material changes from a semisolid to plastic state; the liquid limit, from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 5, but in table 7 the data on liquid limit and plasticity index are based on tests of soil samples.

Permeability is that quality of a soil that enables it to transmit water or air. It is estimated on the basis of soil characteristics observed in the field, particularly structure and texture. The estimates in table 5 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

Available water capacity is the ability of soil to hold water for use by most plants. It is commonly defined as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most crop plants.

Reaction is the degree of acidity or alkalinity of a soil, expressed in pH values. The pH value and terms used to describe soil reaction are defined in the Glossary.

Salinity refers to the amount of soluble salts in the soil. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25° C. Salinity affects the suitability of a soil for crop production, its stability when used as construction material, and its corrosiveness to metals and concrete.

Shrink-swell potential is the extent to which the soil shrinks as it dries out or swells when it gets wet. It is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils causes much damage to building foundations, roads, and other structures. A *high* shrink-swell potential indicates a hazard to maintenance of structures built in, on, or with material having this rating.

Corrosivity, as used in table 5, pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel. Rate of corrosion of uncoated steel is related to such soil properties as drainage, texture, total acidity, and electrical conductivity. Installations of uncoated steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations entirely in one kind of soil or one soil horizon. A corrosivity rating of *low* means that there is a low probability of soil-induced corrosion damage. A rating of *high* means that there is a high probability of damage, so that protective coatings for steel should be used to avoid or minimize damage.

Engineering interpretations of the soils

The estimated interpretations in table 6 are based on the engineering properties of soils shown in table 5, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Contra Costa County. In table 6, ratings are used to summarize limitation or suitability of the soils for all listed purposes other than for embankments, reservoirs, drainage for crops and pasture, and irrigation. For these uses, table 6 lists those soil features not to be overlooked in planning, installation, and maintenance.

Soil limitations are indicated by the ratings *slight, moderate,* and *severe. Slight* means that soil properties are generally favorable for the rated use, or that limitations are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but limitations can be overcome or modified by special planning and design. *Severe* means that soil properties are so unfavorable and limitations are so difficult to correct or overcome as to require major soil reclamation, special design, or intensive maintenance.

Soil suitability is rated by the terms *good, fair,* and *poor* which have, respectively, about the same meanings as *slight, moderate,* and *severe.*

Following are explanations of some of the columns in table 6.

Local roads and streets have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep.

Soil properties that most affect design and construction of roads and streets are the load-supporting capacity and stability of the subgrade and the workability and quantity of the cut and fill material available. The AASHTO and Unified classifications of the soil material and the shrink-swell potential indicate traffic-supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect ease of excavation and amount of cut and fill needed to reach an even grade.

Septic tank filter fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material from a depth of 18 inches to 6 feet is evaluated for properties that affect both absorption of effluent and construction and operation of the system. Permeability, depth to the water table or rock, and susceptibility to flooding affect absorption. Slope affects difficulty of layout and construction and also the hazard of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Dwellings without basements are not more than three stories high and are supported by foundation footings placed in undisturbed soil. Properties that affect the suitability of a soil for dwellings are those that relate to the capacity to support load and resist

settlement under load and those that relate to ease of excavation. Wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential affect the capacity to support load. Wetness, slope, depth to bedrock, and content of stones and rocks affect ease of excavation.

Sanitary landfill is a method of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil material throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, can withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated, the ratings in table 6 apply only to a depth of about 6 feet or to rock if encountered at a depth of less than 6 feet, and therefore limitation ratings of *slight* or *moderate* are not valid in all places if trenches are to be much deeper. For some soils, reliable predictions can be made to a depth of 10 to 15 feet, but every site should be investigated before a selection is made.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Properties that affect suitability include ease of working and spreading the soil material, as for preparing a seedbed; natural fertility of the soil or the response of plants when fertilizer is applied; and absence of substances toxic to plants. Texture of the soil material and the content of stone fragments affect suitability, but also considered in the ratings is the damage that will result at the area from which topsoil is taken.

Road fill is soil material used in embankments for roads. The ratings reflect (1) the predicted performance of soil after it has been placed in an embankment that is properly compacted and provided with adequate drainage, and (2) the relative ease of excavating the material at borrow areas.

Embankments require soil material that is resistant to seepage and piping and that has favorable stability, shrink-swell potential, shear strength, and compactibility. Presence of stones or organic material are among the unfavorable factors.

Reservoir areas hold water behind a dam or embankment. Soils suitable for reservoir areas have low seepage, which is affected by their permeability and depth to fractured or permeable bedrock or other permeable material (fig. 9).

Drainage for crops and pasture is affected by such soil properties as permeability, texture, and structure; depth to claypan, rock or other layers that influence rate of water movement; depth to the water table; slope; stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

Irrigation of a soil is affected by such properties as slope; susceptibility to stream overflow, water erosion, or soil blowing; texture; content of stones; accumulation of salts and alkali; depth to which roots can penetrate; rate of water intake at the surface; permeability of soil layers below the surface layer and in

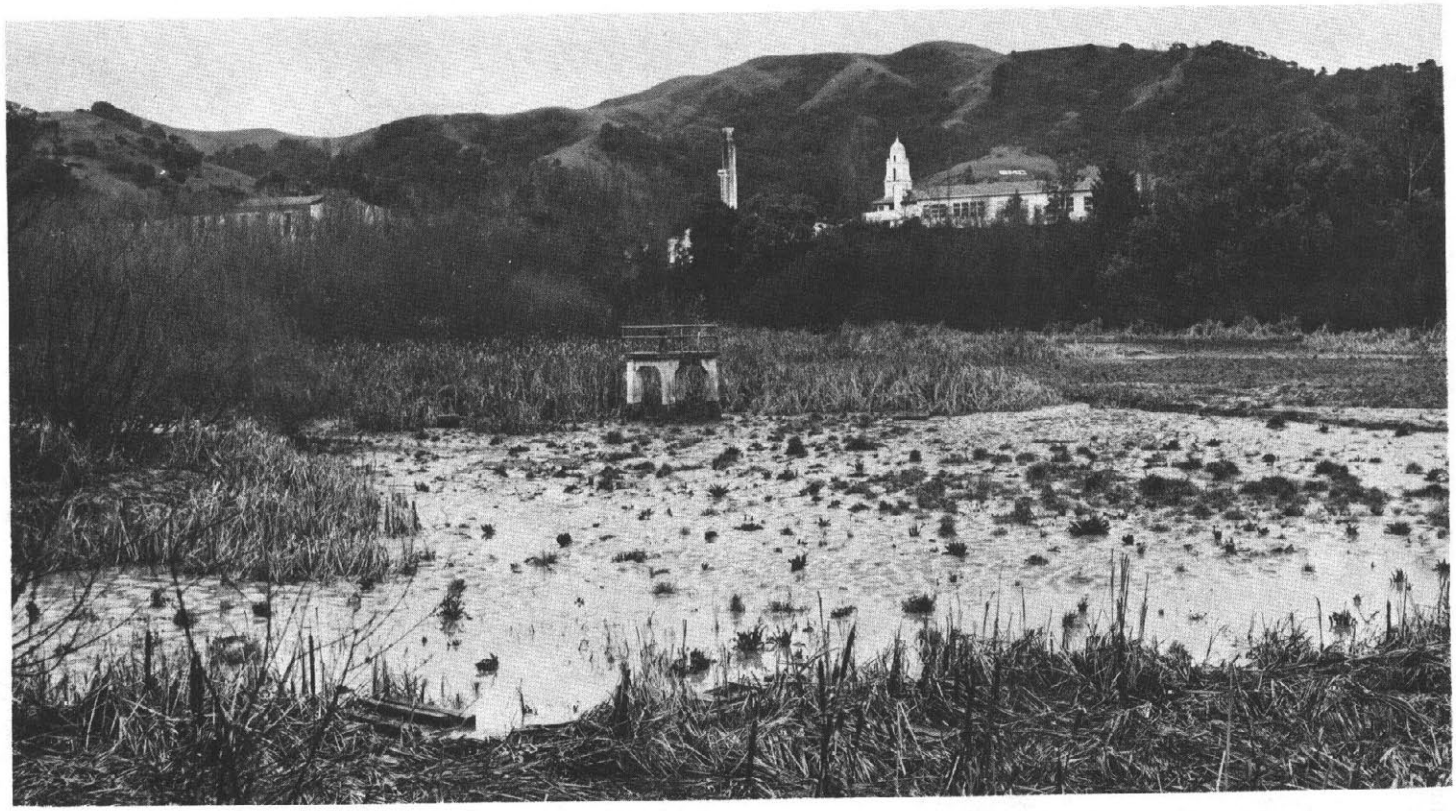

Figure 9.—**In the Los Osos-Los Gatos complex, reservoirs are filled with sediment from housing construction sites where the soils are bare. Runoff from these areas is rapid and the hazard of erosion is high.**

fragipans or other layers that restrict movement of water; available water capacity; and need for drainage, or depth to water table or bedrock.

Engineers and soil scientists have classified the soils in the county into four hydrologic soil groups. The grouping is based on estimates of the intake of water during a storm of long duration after the soil profile is wet and has an opportunity to swell, without the protective effect of any vegetation. Hydrologic soil groups help an engineer or hydrologist estimate the amount of runoff expected from a watershed for a given storm. The four hydrologic soil groups are designated A, B, C, and D. Group A soils have the highest infiltration rates and the lowest runoff potential. Group D soils have the slowest infiltration rates and the highest runoff potential. Groups B and C are intermediate in infiltration rates and runoff.

Landslides

No attempt has been made to rate the soils of Contra Costa County as to their susceptibility to landslides or land slips, but this is a very prevalent phenomenon in the county (fig. 10).

Landslides occur when the pull of gravity overcomes the frictional resistance of a soil mass to downhill movement. A recently published USGS report (*11*) lists seven natural factors affecting slope stability. These are the type of earth materials; structural properties of the earth materials; steepness of slopes; water; ground shaking; type of vegetation; and proximity of areas undergoing active erosion. In addition to these natural factors, unwise development of the soils is an eighth factor.

All of these factors exist in Contra Costa County, and from a study of data shown in table 5, some deductions can be made as to the probable susceptibility of a given soil to landslide. An example is the steep Altamont soils. These are clay soils that have slopes of as much as 50 percent, have low shear strength, and are only 48 inches deep to bedrock. Such soils, lacking vegetative protection, are quite susceptible to landslides, especially if man has altered the natural slope in such a way as to steepen it, particularly on lower parts of the slope. The steeper Sehorn soils that have slopes of as much as 75 percent are also susceptible to landslides.

Soil test data

Table 7 gives engineering test data for some of the major soil series in Contra Costa County. These tests were made to help evaluate the soils for engineering purposes. The engineering classifications given are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

Compaction (or moisture-density) characteristics are important in earthwork. If a soil material is compacted at successively higher moisture content, assuming that the compactive effort remains constant, the density of the compacted material increases until the *optimum moisture content* is reached. After that, den-

***Figure 10.*—Soil slips or landslides are common in some areas of Los Osos clay loam where the slope is 30 to 75 percent.**

sity decreases with increase in moisture content. The highest dry density obtained in the compactive test is termed *maximum dry density*. As a rule, the maximum strength of earthwork is obtained if the soil is compacted to its maximum dry density.

Tests to determine liquid limit and plastic limit measure the effect of water on the consistence of soil material, as has been explained for table 5.

Formation and Classification of Soils [4]

In this section the factors that affect the formation of soils in Contra Costa County are discussed, and important processes in the morphology are described. Then the classification of the soils by higher categories is given.

Factors of Soil Formation

Soils are composed of organic and mineral material. They differ in appearance, composition, productivity, and management requirements in different places and even within small areas. The five factors of soil formation that cause soils to differ are climate, landscape (or relief), parent material, plants and animals, and time. The relative affect of each of these factors varies from one soil to another.

The processes of soil formation are quite complex. Their influence and relationship are more easily described by comparing soils in similar landforms or geomorphic units. In the paragraphs that follow, climate and landscape are discussed first. Then all five factors of soil formation are considered as they relate to each of the geomorphic units of the county.

Climate

The climate of Contra Costa County varies from place to place, but the overall differences in temperature and precipitation are not extreme. The climate is mild. Winters are cool and moist, and summers are warm and dry. Along San Francisco Bay, the summers are cool, and there are frequent sea breezes and early morning fog.

The summers are hotter inland where warm dry weather prevails. The average annual rainfall is about 22 inches near Berkeley and about 12 to 15 inches in the eastern part of the county. Precipitation effectiveness is greater in cooler areas near the bay and on steep north-facing slopes.

The soils are moist from late in fall to early in spring and are dry the rest of the year. Berkeley has about 11 inches of moisture in excess of evapotranspiration requirements, and parts of the county near Antioch, Livermore, and Stockton have about 6 inches of effective moisture. The surplus is not sufficient for active leaching. Very little leaching occurs in the deeper soils. The redistribution of carbonates and translocation of clays is slow. Most soils have a good supply of bases, and many lack a prominent argillic horizon.

The warm temperatures when the soils are moist and generally warm temperatures throughout the year favor rapid decomposition of organic matter and retard its accumulation. The soils are rarely frozen, so the surface layer is not broken up by frost action and is not well granulated. Many soils have a massive, hard surface layer somewhat deficient in organic matter. Soils that have a darker colored and softer surface layer are generally in the more moist areas.

Many of the soils are dry below a depth of 20 inches in summer and fall unless they are irrigated. During this period many biological and chemical processes are retarded. The alternate wet and dry cycle causes the soils high in montmorillinitic clays to shrink and swell. Large cracks develop in such soils as Altamont and Diablo. Surface material sloughs into cracks and becomes mixed with material in the lower layers, restricting textural differentiation within the soil profile.

Landscape

Contra Costa County is bordered on the west by the San Francisco Bay, on the north by the Carquinez Straits and Suisun Bay, and on the north and east by the Sacramento and San Joaquin Rivers. A major part of the county is in the Coast Range geomorphic province. The easternmost part, including the area around the confluence of the Sacramento and San Joaquin Rivers, is in the Great Valley province.

The Coast Range is generally hilly to very steep. Folds, thrusts, and faults form a series of nearly parallel, northwest-trending ridges made up mostly of steeply dipping sedimentary rocks. Mount Diablo, at 3,849 feet, is the highest peak in the area. It is located in about the center of the county, among the ridges along the eastern sector of the Coast Range. These ridges are higher than those to the west. The ridges overlooking San Francisco Bay average about 500 to 1,500 feet in height. Between the ridges is a series of small valleys filled with alluvium on small fans and flood plains. The ridges bordering the San Francisco and Suisun Bays are skirted by terraces and alluvial fans that merge into the tidal flats adjacent to the bays.

The Great Valley is partly a river flood plain that has meandering channels and overflow lands. Here the Sacramento and San Joaquin Rivers join, forming a delta, and then flow into the Suisun Bay. Large areas of soils are at or below sea level. Reclaimed swamp is protected by dikes and natural levees. West of the delta along the boundary with the Coast Range and extending toward Suisun Bay are small elevated terraces, sloping alluvial fans, and scattered remnants of a windblown terrain.

Formation of the soils by geomorphic units

Contra Costa County can be divided into four units based on differences in landforms. The interaction of soil-forming factors differs for each, and the soil relationships in the units are significantly different. The units are hilly to very steep uplands in the Coast Range; terraces, fans, and flood plains in the valleys;

[4] By GRANT KENNEDY, soil specialist, Soil Conservation Service.

river channels and delta overflow land; and tidal flats of the bays.

HILLY TO STEEP UPLANDS IN THE COAST RANGE

The upland areas of the Coast Range are made up of sedimentary rocks but include some metamorphic and basic igneous rocks. Many ridges are composed of interbedded shale, siltstone, sandstone, claystone, and conglomerate that are folded and faulted and have steep side slopes. Some strata contain volcanic material deposited in a marine environment.

The parent material of a number of soils is shale, siltstone, mudstone, and argillaceous sandstone. They contain fine silt or clay materials, or they readily weather to clay. The clay from these sources is mainly montmorillinitic. The rock materials are lime-enriched or contain many seams of lime. The rocks are not extremely hard and are fractured. They are susceptible to rapid weathering.

The steep slopes affect soil stability. Clayey materials creep and slide as soils form. Landslides, slips, slumps, and erosion often keep pace with soil formation, depositing debris along foot slopes and bottoms of valleys. Lodo soils are an example of shallow soils where erosion has proceeded about as fast as soil formation.

Alo, Altamont, Diablo, and Los Osos soils are deeper. They formed in softer parent material that is more easily weathered. Altamont, Alo, and Diablo soils are expansive clay soils that have little horizon differentiation. Los Osos soils formed in harder parent material. They are not so expansive as the Alo, Altamont, and Diablo soils and have an argillic horizon. Los Osos soils have a more permeable surface layer than the Altamont and Diablo soils, which accounts for their greater instability, because the horizons become saturated more quickly during heavy rains.

Some rocks are less easily weathered, and the soils are shallow. Gaviota and Briones soils formed in siliceous sandstone which weathered to form sandy soils. These soils are also very susceptible to erosion, which partly accounts for their shallow depth.

The vegetation over much of the Coast Range is annual grass and scattered oaks. Shrubs and dense stands of oak, bay leaf, and madrone are on more moist sites. Coastal redwood, madrone, and ferns are in cooler, more moist areas on steep, north-facing slopes. The grass furnishes enough organic matter to darken the soils to a depth of 10 inches. The organic-matter content is more than 1 percent in almost all soils that have a cover of grass and is higher on more moist and cooler sites.

Felton soils are very steep soils on north-facing slopes. They formed under redwoods and ferns and are more than 40 inches deep. Their A horizon is thick and dark colored. The vegetation is a factor in soil depth and the thickness of the A horizon. The trees stabilize the steep soil, and tree roots help to further disintegrate the fractured bedrock. Organic residue accumulates from slowly decaying tree and fern litter.

Livestock have grazed the hills of the Coast Range from the time of the Spanish missions in the early 1800's to the present. At times there were so many animals that the grasslands were overgrazed and erosion was accelerated. Trails nearly on the contour or terracettes are visible on most steep grassy slopes. Gulleys are prevalent in deeper soils along ravines and concave slopes.

More recently, man has altered the landscape near urban centers. Large areas have been cut and filled for urban works and structures. Machines can excavate the marine sediments and reshape the landscape. The land is altered or made with a variety of materials from soil cuts. Erosion is often severe on cut and fill slopes. Landslides, slips, and slumps are more frequent because of manipulation of the soil.

FLOOD PLAINS, FANS, AND TERRACES IN THE VALLEYS

Most valleys in the county are relatively small, except for the San Joaquin Valley near Brentwood. The smaller valleys are in troughs or folds between the coastal ridges. The streams draining the surrounding hills are not large, and stream gradients are slight in the valleys. The valley fill material is fine-grained sediment eroded from the adjacent Coast Range. Drainage is poor in parts of the flood plain and in basins. The soils are well drained on fans and terraces above the valley floors.

Some valley flood plains have depressions or basins that are ponded in wet seasons. Clear Lake soils formed in poorly drained basins. They have a thick, dark-colored surface layer and mottled, calcareous lower horizons. Stream entrenchment has lowered the water table so that the montmorillonitic clays shrink in dry seasons and swell in wet seasons. Cracks open at the surface and extend into the C horizon, forming slickensides.

Fine-textured alluvium was also deposited in the valleys, forming well-drained, gently sloping alluvial fans. Cropley soils formed on these fans. They are not so moist as Clear Lake soils, have a thinner A horizon, and lack mottles. Otherwise they are similar in appearance.

Calcareous sediment, some of which is caused by man, was eroded and deposited near the outlets of Walnut and Pine Creeks and impeded drainage. The alluvium was seasonally saturated, and mottles formed near the surface. Sycamore soils formed in this material.

Several soils formed on rims of basins where sodium was concentrated near the surface by capillary rise from a water table and by lateral movement of ground water from higher areas. The exchangeable sodium dispersed the clay particles, and columnar and prismatic structure formed in subsurface horizons. Solano and Pescadero soils, which have natric horizons, formed on rims of basins.

Scattered benches along the sides of valleys are remnants of terraces. They are older landscapes that remained fairly stable as erosion continued carving out and lowering the valleys and raising the uplands. The soils on terraces had a longer time to form than other soils. They developed prominent morphologic features principally associated with the translocation and accumulation of silicate clays. Tierra and Antioch

soils are on benches. They have a thin, loamy A1 horizon, a lighter colored A2 horizon, and an abrupt boundary to a clay Bt horizon that has prismatic or columnar structure. Antioch soils formed in parent material that contains enough exchangeable sodium to influence the lower horizons.

The terrain near Oakley and Brentwood in the San Joaquin Valley is windblown. Prevailing winds from the San Francisco Bay come through the Carquinez Straits inland and blow southeasterly from Suisun Bay. Sand blown inland from sandbars and beaches when the climate was dryer formed hummocky to gently sloping relief. More moist conditions prevailed in recent times, and vegetation stabilized most of the sandy soil. A few shifting dunes formed where the soil has been disturbed. Delhi soils formed in these sands. They have no horizon differentiation other than a slightly darkened A horizon. In many places the A horizon and the original relief have been altered by reshaping the surface for crops or other land uses.

Urban communities have spread out and are continuing to expand into farming areas in the valleys. The soils are altered for urban works and structures. In general, the soils were less altered in urban areas built up before heavy earth-moving equipment was available. Nearly level or gently sloping soils have had less cutting and filling than steeper soils. The surface horizon of most of the soils has been changed.

DELTA PLAIN

The delta plain lies along the lower course of the San Joaquin River near the junction with the Sacramento River. It consists of areas adjacent to meandering channels and sloughs protected by artificial dikes and natural levees and drained by pumping plants. The soils are near or below sea level. All are intensively cultivated.

The delta plain was once a freshwater marsh, and the soils formed in the accumulated remains of tule, reeds, and other aquatic plants. Thin layers of silty mineral matter were added when the rivers flooded. The major channels occupied their present position during the period of organic-matter accumulation. As the mineral base subsided, organic deposits accumulated, and the streams built up bordering alluvial ridges. Tracts were reclaimed around the turn of the century by leeves and drainage. The organic fibers from the tule and reeds are partly decomposed, and most are easily destroyed by rubbing. Pumping has lowered the water table and allowed the soils to dry. The soils dry irreversibly. Cracks develop that remain even after rewetting. These organic soils have subsided as a result of drying, oxidation, soil blowing, fires, and tillage. The organic-matter content has been diluted as thin layers of minerals collected in the residual organic soil.

Venice, Rindge, Webile, and Shima soils are the organic soils of the delta plain. They have an organic-matter content of about 50 to 80 percent, by ignition. The organic-matter content is least at the surface and increases with depth. Venice soils are the least decomposed. They consist of deep, dark yellowish-brown fibrous material under a darker colored surface layer. The fibers are only partly destroyed when they are rubbed. Rindge, Shima, and Webile soils are most decomposed. Rindge soils consist of deep, black organic material. They have fewer visible fibers than Venice soils, and most of the fibers can be destroyed by rubbing. Shima and Webile soils are similar in appearance to Rindge soils, but Shima soils are underlain by sand at a depth of about 16 to 36 inches, and Webile soils are underlain by silty clay and clay at a depth of 27 to 51 inches.

Associated with the organic soils on the delta plain are Ryde, Egbert, Merritt, and Piper soils. Ryde and Merritt soils consist of stratified mineral and organic layers formed by thick deposits of sediment during several river floods. Egbert soils formed in poorly drained silty clay loam alluvium. They had a thin surface layer of organic material that oxidized and mixed with the underlying mineral soil. They now have a dark-gray mineral A horizon that contains much organic matter and is underlain by gleyed silty clay loam and clay. Piper soils formed in windblown material that had encroached on the northwest part of the delta. The surface of Piper soil has had additions of organic material. The B2 horizon has been weakly cemented by carbonates from a fluctuating water table.

TIDAL FLATS OF THE BAYS

The tidal flats in Contra Costa County are tidal marshes at approximately mean high water that are daily inundated by high tides. They are around the edges of the San Francisco, San Pablo, and Suisun Bays. The Sacramento and San Joaquin Rivers have carried sediment into the bays. The suspended sediment is fine—mostly clay and silt. Investigations report an average composition of about 57 percent clay in the suspended sediment (*6*).

Tidal action, currents, and waves have deposited clay and silt in the shallow water around the perimeter of the bays. These particles were moved about and reworked by flood and ebb tides, and eventually the surface rose slightly above sea level. Salt-tolerant plants, such as cordgrass and pickleweed, became established. The plants helped trap additional sediment and stabilize the soil against erosion. In places the sediment slowly subsided, and organic matter accumulated as it settled, forming thick organic deposits. The bay mud was impregnated with salts from the brackish bay water and contained reduced sulphur compounds.

Joice and Reyes soils formed on the tidal areas. Joice soils are deep, dark-colored, fibrous, organic soils. The fibers are fairly well decomposed and most are destroyed when rubbed. The organic-matter content is from 30 to 45 percent, by ignition. Reyes soils are dark-colored, gleyed silty clay. They are about 5 to 10 percent organic matter. Both the Joice and Reyes soils dry irreversibly. They shrink and crack, and the cracks remain after rewetting. Both soils become strongly acid when exposed to air. A yellow efflorescence of jarrosite is found in places on drained areas of Reyes soils.

Classification of Soils

Soils are classified so that we can more easily remember their significant characteristics, assemble knowledge about them, see their relationship to one another and to the whole environment, and develop principles that help us to understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and apply knowledge about soils in managing farms, fields, and woodlands, in developing rural areas, in engineering work, and in many other ways. Soils are placed in broad classes to facilitate study and comparison over large areas, such as countries and continents.

The system of soil classification currently in use was adopted by the National Cooperative Soil Survey in 1965 (*9*). Because this system is under continual study, readers interested in developments of the current system should refer to the latest literature available.

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. The criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped together. In table 8, the soil series of Contra Costa County are placed in 3 categories—family, subgroup, and order. Classes of the current system are briefly defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are the Entisols and Histosols, found in many different climates. Each order is designated by a name of three or four syllables ending in *sol* (Ent-i-sol).

SUBORDER. Each order is divided into suborders that are based primarily on those soil characteristics that seem to produce classes that have the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of water-logging, or soil differences resulting from the climate or vegetation. The names of suborders have two syllables. The last syllable indicates the order. An example is *Aquent* (*Aqu*, meaning water or wet, and *ent*, from Entisol).

GREAT GROUP. Suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated; those that have pans that interfere with growth of roots, movement of water, or both; and thick, dark-colored surface horizons. The features used are the self-mulching properties of clay, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the dark-red and dark-brown colors associated with basic rocks, and the like. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder. An example is Haplaquents (*Hapl*, meaning simple horizons, *aqu*, for wetness or water, and *ent*, from Entisols).

SUBGROUP. Great groups are divided into subgroups, one representing the central (typic) segment of the group, and others called intergrades that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups are also made in instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Typic Haplaquents (a typical Haplaquent).

FAMILY. Soil families are separated within a subgroup primarily on the basis of properties important to the growth of plants or on the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names for texture, mineralogy, and so on, that are used to differentiate families (see table 8). An example is coarse-loamy, siliceous, acid, thermic family of Typic Haplaquents.

The six soil orders in Contra Costa County are Alfisols, Entisols, Histosols, Inceptisols, Mollisols, and Vertisols. These orders and the great groups and subgroups of each are discussed in the following paragraphs.

Alfisols

The Alfisols are mineral soils that are moist during part of the growing season. They have a clay-enriched B horizon that has translocated clays and moderate to high saturation of bases. They lack a thick, dark-colored surface horizon. The Alfisols of Contra Costa County are divided into three great groups—Haploxeralfs, Natrixeralfs, and Palexeralfs—and seven subgroups.

HAPLOXERALFS are well-drained soils that have a gradual increase in clay content from the A to the Bt horizon.

Typic Haploxeralfs have a low organic-matter content and a pale-colored A horizon that is massive and hard when dry. Dibble soils are in this subgroup.

Mollie Haploxeralfs have a darker colored A horizon than is typical. Their A horizon is massive and hard, and dark colors extend to a depth of more than 4 inches. Perkins, Rincon, and Zamora soils are in this subgroup.

Lithic-Ruptic Xerochreptic Haploxeralfs are underlain by hard, undulating bedrock that is near the surface in places, replacing the Bt horizon. Vallecitos soils are in this subgroup.

TABLE 8.—*Classification of soil series*

Series	Family	Subgroup	Order
Alo	Fine, montmorillonitic, thermic	Typic Chromoxererts	Vertisols.
Altamont	Fine, montmorillonitic, thermic	Typic Chromoxererts	Vertisols.
Antioch	Fine, montmorillonitic, thermic	Typic Natrixeralfs	Alfisols.
Botella	Fine-loamy, mixed, thermic	Pachic Argixerolls	Mollisols.
Brentwood	Fine, montmorillonitic, thermic	Typic Xerochrepts	Inceptisols.
Briones [1]	Mixed, thermic	Typic Xeropsamments	Entisols.
Capay	Fine, montmorillonitic, thermic	Typic Chromoxererts	Vertisols.
Clear Lake	Fine, montmorillonitic, thermic	Typic Pelloxererts	Vertisols.
Conejo	Fine-loamy, mixed, thermic	Pachic Haploxerolls	Mollisols.
Cropley	Fine, montmorillonitic, thermic	Chromic Pelloxererts	Vertisols.
Delhi	Mixed, thermic	Typic Xeropsamments	Entisols.
Diablo	Fine, montmorillonitic, thermic	Chromic Pelloxererts	Vertisols.
Dibble	Fine, montmorillonitic, thermic	Typic Haploxeralfs	Alfisols.
Egbert	Fine, mixed, thermic	Fluvaquentic Haplaquolls	Mollisols.
Felton	Fine-loamy, mixed, mesic	Ultic Argixerolls	Mollisols.
Fontana	Fine-loamy, mixed, thermic	Calcic Haploxerolls	Mollisols.
Garretson	Fine-loamy, mixed, nonacid, thermic	Typic Xerorthents	Entisols.
Gaviota	Loamy, mixed, nonacid, thermic	Lithic Xerorthents	Entisols.
Gilroy	Fine-loamy, mixed, thermic	Typic Argixerolls	Mollisols.
Joice	Clastic, euic, thermic	Typic Medisaprists	Histosols.
Kimball	Fine, montmorillonitic, thermic	Mollic Palexeralfs	Alfisols.
Kingile	Clayey, mixed, euic, thermic	Terric Medisaprists	Histosols.
Laugenour	Coarse-loamy, mixed (calcareous), thermic	Aeric Fluvaquents	Entisols.
Linne	Fine-loamy, mixed, thermic	Calcic Pachic Haploxerolls	Mollisols.
Lodo	Loamy, mixed, thermic	Lithic Haploxerolls	Mollisols.
Los Gatos	Fine-loamy, mixed, mesic	Typic Argixerolls	Mollisols.
Los Osos	Fine, montmorillonitic, thermic	Typic Argixerolls	Mollisols.
Los Robles	Fine-loamy, mixed, thermic	Typic Xerochrepts	Inceptisols.
Marcuse	Fine, montmorillonitic (calcareous), thermic	Vertic Haplaquepts	Inceptisols.
Merritt [2]	Fine-silty, mixed, thermic	Fluvaquentic Haploxerolls	Mollisols.
Millsholm	Loamy, mixed, thermic	Lithic Xerochrepts	Inceptisols.
Omni	Fine, montmorillonitic (calcareous), thermic	Fluvaquentic Haplaquolls	Mollisols.
Perkins	Fine-loamy, mixed, thermic	Mollic Haploxeralfs	Alfisols.
Pescadero	Fine, montmorillonitic, thermic	Aquic Natrixeralfs	Alfisols.
Piper	Coarse-loamy, mixed (calcareous), thermic	Aeric Haplaquepts	Inceptisols.
Positas	Fine, montmorillonitic, thermic	Mollic Palexeralfs	Alfisols.
Reyes	Fine, mixed, acid, thermic	Sulfic Haplaquepts	Inceptisols.
Rincon	Fine, montmorillonitic, thermic	Mollic Haploxeralfs	Alfisols.
Rindge	Euic, thermic	Typic Medisaprists	Histosols.
Ryde	Fine-loamy, mixed, thermic	Cumulic Haplaquolls	Mollisols.
Sacramento	Very-fine, montmorillonitic, thermic	Vertic Haplaquolls	Mollisols.
San Ysidro	Fine, montmorillonitic, thermic	Typic Palexeralfs	Alfisols.
Sehorn	Fine, montmorillonitic, thermic	Entic Chromoxererts	Vertisols.
Shima	Sandy, mixed, euic, thermic	Terric Medisaprists	Histosols.
Solano	Fine-loamy, mixed, thermic	Typic Natrixeralfs	Alfisols.
Sorrento	Fine-loamy, mixed, thermic	Calcic Haploxerolls	Mollisols.
Sycamore	Fine-silty, mixed, nonacid, thermic	Aeric Haplaquepts	Inceptisols.
Tierra	Fine, montmorillonitic, thermic	Mollic Palexeralfs	Alfisols.
Vallecitos	Clayey, montmorillonitic, thermic	Lithic Ruptic-Xerochreptic Haploxeralfs.	Alfisols.
Venice	Euic, thermic	Typic Medihemists	Histosols.
Webile	Clayey, mixed, euic, thermic	Terric Medisaprists	Histosols.
Zamora	Fine-silty, mixed, thermic	Mollic Haploxeralfs	Alfisols.

[1] Briones fine sandy loam, 2 to 5 percent slopes (BeB) is classified as an Aquic Xerochrept, coarse-loamy, mixed, thermic. Areas of Briones loamy sand, 30 to 50 percent slopes, eroded (BdF2), that are less than 20 inches deep to soft sandstone are classified as Typic Xeropsamments, mixed, thermic, shallow.

[2] The Merritt soils mapped in Contra Costa County are taxadjuncts to the Merritt series. They are noncalcareous throughout and contain relatively large amounts of micaceous material.

NATRIXERALFS formed in the presence of sodium which dispersed particles of clay, forming a Bt horizon that has columnar and prismatic structure and a high level of exchangeable sodium.

Typic Natrixeralfs are well-drained soils that are saturated for short periods during the wet season because of their slow permeability. Antioch and Solano soils are in this subgroup.

Aquic Natrixeralfs are wetter than is typical. They have low-chroma mottles within a depth of 30 inches and are saturated in the mottled layer because of a seasonal high water table. Pescadero soils are in this subgroup.

PALEXERALFS are well-drained soils that have a clayey Bt horizon with an abrupt upper boundary.

Typic Palexeralfs have a low organic-matter content and a pale-colored or thin, darker colored A horizon that is massive and hard when dry. San Ysidro soils are in this subgroup.

Mollic Palexeralfs have a darker colored A horizon than is typical. They have a higher organic-matter content but either are massive and hard when dry or are not thick enough to be classified as mollic epipedons. Kimball, Positas, and Tierra soils are in this subgroup.

Entisols

The Entisols are mineral soils that show little or no evidence of pedogenic horizons. Generally, too little time has passed for soil horizons to form. Entisols are commonly on steep, actively eroding slopes or on flood plains. The Entisols of Contra Costa County are divided into three great groups—Fluvaquents, Xerorthents, and Xeropsamments—and four subgroups.

FLUVAQUENTS formed on flood plains where periodic deposition has taken place. They are saturated near the surface at times.

Aeric Fluvaquents are not so wet as is typical. They have high-chroma mottles between depths of 10 and 20 inches because they are not saturated for long periods. Laugenour soils are in this subgroup.

XERORTHENTS formed on recently eroded surfaces. They are moist in winter and very dry in summer.

Typic Xerorthents are moderately deep or deep soils that formed in recent alluvium from sedimentary rock. Garretson soils are in this subgroup.

Lithic Xerorthents are less than 20 inches deep to hard rock. They formed on sloping uplands over hard sandstone. Gaviota soils are in this subgroup.

XEROPSAMMENTS are soils that formed in shifting or stabilized sand dunes, water-deposited sand, or sandy parent material, such as siliceous sandstone. They are moist in winter and very dry in summer.

Typic Xeropsamments are moderately deep and deep sandy soils that are excessively drained and that show no evidence of cementation or clay accumulation. Briones and Delhi soils are in this subgroup. Briones soils are on uplands. They formed in material weathered from siliceous sandstone and are highly susceptible to erosion. Delhi soils formed in deposits of windblown sand.

Histosols

The Histosols are mainly organic and formed in bogs, marshes, and river deltas that were saturated most of the time. The Histosols of Contra Costa County are divided into two great groups—Medihemists and Medisoprists—and three subgroups.

MEDIHEMISTS are organic soils that are partly decomposed. Many fibers are destroyed when the soils are rubbed or mechanically disturbed. These soils are at mid-latitudes where temperatures are mild or warmer.

Typic Medihemists are deep organic soils that have no significant mineral layers in the subsurface horizons. Venice soils are in this subgroup.

MEDISAPRISTS are black organic soils that consist almost entirely of decomposed organic remains. The remaining fibers are easily destroyed when rubbed or mechanically disturbed.

Typic Medisaprists are deep organic soils that have no significant mineral layers in the subsurface horizons. No subsurface horizons have significant layers of less-decomposed organic material. Joice and Rindge soils are in this subgroup.

Terric Medisaprists are organic soils that consist almost entirely of decomposed organic remains underlain by mineral layers below a depth of 16 to 51 inches. Kingile, Shima, and Webile soils are in this subgroup.

Inceptisols

The Inceptisols are mineral soils that are beginning to develop altered horizons. They are in areas where there is sufficient moisture to remove bases, iron, or aluminum. They lack an illuvial horizon enriched by silicate clays.

The Inceptisols of Contra Costa County are divided into two great groups—Haplaquepts and Xerochrepts —and six subgroups.

HAPLAQUEPTS are poorly drained or very poorly drained, wet soils. They are in areas where little or no rain falls for part of the year, and capillary rise brings sodium or salts to the surface.

Aeric Haplaquepts formed under better natural drainage and are better aerated than is typical. They lack low-chroma mottles near the surface. Piper and Sycamore soils are in this subgroup.

Sulphic Haplaquepts formed in the presence of brackish water and iron sulphide. They have jarrosite mottles and are extremely acid when exposed to air and dried. Reyes soils are in this subgroup.

Vertic Haplaquepts contain more clay than is typical. They develop wide cracks to a depth of 20 inches almost every year. Marcuse soils are in this subgroup.

XEROCHREPTS are light-colored, brownish, well-drained soils that are moist in winter and spring but are thoroughly dry in summer.

Typic Xerochrepts are thick, well-drained soils that have a high base saturation and that lack a horizon enriched by calcium carbonate. Brentwood and Los Robles soils are in this subgroup.

Lithic Xerochrepts are shallow, steep soils underlain by bedrock. Otherwise they are like the Typic Xerchrepts. Millsholm soils are in this subgroup.

Aquic Xerochrepts are thick soils that have mottles within a depth of 30 inches. Otherwise they are like the Typic Xerochrepts. Briones fine sandy loam is in this subgroup.

Mollisols

The Mollisols are dark-colored mineral soils, most of which formed under a cover of grass. The structure of their surface horizon is commonly granular or subangular blocky, and the horizon is soft or only slightly hard when dry. The soils are rich in bases.

The Mollisols of Contra Costa County are divided into three great groups—Argixerolls, Haplaquolls, and Haploxerolls—and eleven subgroups.

ARGIXEROLLS are well-drained soils that are moist in winter and spring and have accumulated translocated clay in subsurface horizons.

Typic Argixerolls are moderately deep or deep and have a moderately thick, dark-colored surface horizon. Gilroy, Los Gatos, and Los Osos soils are in this subgroup.

Pachic Argixerolls have a thick, dark-colored surface horizon. Botella soils are in this subgroup.

Ultic Argixerolls have a lower base saturation than is typical—less than 75 percent. They formed on steep, north-facing slopes where moisture conditions favor a cover of redwood, madrone, and fern. Felton soils are in this subgroup.

HAPLAQUOLLS are Mollisols that formed under poor or very poor natural drainage and that have gray or olive-gray mottled lower horizons.

Cumulic Haplaquolls have a thicker dark-colored surface horizon than is typical. Ryde soils are in this subgroup.

Fluvaquentic Haplaquolls formed where there is periodic flooding and deposition. They are mottled, and organic-matter content decreases irregularly as depth increases. Egbert and Omni soils are in this subgroup.

Vertic Haplaquolls are clay soils that are dry in the upper horizons part of the time. During summer they develop wide cracks to a depth of 20 inches because of a low water table. Sacramento soils are in this subgroup.

HAPLOXEROLLS are well-drained Mollisols that are moist in winter and spring and that lack any significant increase of translocated clay in their subsurface horizons.

Calcic Haploxerolls have an accumulation of free carbonates at a shallow depth. Fontana and Sorrento soils are in this subgroup.

Calcic Pachic Haploxerolls have free carbonates at a shallow depth and have a thicker dark-colored surface horizon than is typical. Linne soils are in this subgroup.

Fluvaquentic Haploxerolls formed on nearly level flood plains where periodic deposition has taken place. Their organic-matter content decreases irregularly as depth increases. Merritt soils are in this subgroup.

Lithic Haploxerolls are shallow soils underlain by hard bedrock. Lodo soils are in this subgroup.

Pachic Haploxerolls have a thick, dark-colored surface horizon. Conejo soils are in this subgroup.

Vertisols

The Vertisols are clayey mineral soils that shrink and swell during all seasons and develop deep, wide cracks during dry periods. The Vertisols of Contra Costa County are divided into two great groups—Chromoxererts and Pelloxererts—and four subgroups.

CHROMOXERERTS are well drained or somewhat poorly drained and are brownish in the upper 12 inches.

Typic Chromoxererts are dark brown in the surface horizon, generally because of accumulation of organic matter. Alo, Altamont, and Capay soils are in this subgroup.

Entic Chromoxererts are lighter brown than is typical. Sehorn soils are in this subgroup.

PELLOXERERTS are gray to black in their upper horizons.

Typic Pelloxererts have low chromas to a depth of 40 inches and are dark gray in the surface horizon. Clear Lake soils are in this subgroup.

Chromic Pelloxererts have higher chromas to a depth of 40 inches than is typical. Cropley and Diablo soils are in this subgroup.

General Nature of the County

The first permanent settlement in Contra Costa County dates back to 1823 when the Pinole Grant was issued to Ignacio Martinez and the San Pablo Grant to Francisco Castro. The initial grants were quickly followed by others until, by 1832, most of the more desirable land was privately owned. Settlement gained momentum in the late 1850's, when men returning from the gold fields in the eastern part of the state began farming.

Contra Costa County was established in 1850; Martinez was the county seat. It was one of California's original 27 counties, and it covered about 1,500 square miles. In 1853 nearly half of its acreage went to newly formed Alameda County.

The population of Contra Costa County increased from 78,608 in 1930 to 409,030 in 1960 and to 558,389 in 1970, an increase of 36.5 percent from 1960 to 1970.

Although farming is important to the economy of the county, the influx of people from the larger metropolitan areas to the central part of the county is rapidly reducing the amount of farmland. Private industry in the county has not increased so rapidly as urban growth.

The valley and delta areas in the eastern part of the county are intensively cultivated for row crops, field crops, and orchards. Remnants of the native vegetation remain in very few areas. Some areas in the smaller inland valleys that lack a dependable water supply are used for dryfarmed grain and range.

The mountainous uplands are generally covered by annual grasses and oak and similar vegetation, but brush grows on steep and very steep, rocky soils. Some upland areas in the western part of the county are being invaded by coyote bush.

Physiography and Drainage

Contra Costa County consists of four general physiographic regions: the highland of the Coast Range, the intermountain valleys, the San Francisco Bay depression, and the Sacramento-San Joaquin delta.

The Diablo Range consists of smooth rolling hills to fairly rugged mountains ranging in elevation from near sea level along the San Francisco Bay depression and San Joaquin valley to 3,849 feet at Mount Diablo, a prominent landmark. Most of the mountain valleys are young and V-shaped. The foothills are rolling, generally smooth and gently sloping to very steep hills and ridges. The western hills have a general northwest-southeast trend parallel to San Francisco Bay and are separated from the Mount Diablo block by the San Ramon and Ygnacio valleys.

The San Francisco Bay depression and intermountain valleys consist of mainly level flood plains and

low terraces along with gently rolling fans and some old terrace remnants adjacent to the uplands.

Large areas of windblown sands develop on valley plains where they are cut off on the north by the San Joaquin River.

Most of the low-lying river delta has been reclaimed by protective dikes and drainageways, forming islands of approximately 1,000 to 7,000 acres and a few smaller islands of 30 to 100 acres. Most of the land surface lies at or below sea level, except for a few points that are about 15 feet above sea level.

Except for a few small streams draining west into San Francisco Bay and San Pablo Bay, the drainage of the county enters the San Joaquin River and Suisun Bay to the north. Marsh Creek drains the largest area of any stream originating within the county.

Climate

The climate of Contra Costa County is strongly influenced by its location and topography (*10*). The San Joaquin Valley in the eastern part has hot, dry summers and cool winters. The part adjacent to San Francisco and San Pablo Bays has cool summers and mild winters.

In summer a steady marine wind blows through the Golden Gate and up the Carquinez Strait. Velocities of 15 to 25 knots or more are common late in the afternoon and in the evening, but the velocity is generally 10 knots or less late in the morning. The jet of air sweeping eastward through the straits curls northward and southward in the vicinity of Antioch.

The moderating influence of the marine air is reflected in the July average temperature of 62° F. at Richmond on the bay shore and 74° at Antioch in the east. In January, the reverse effect of this moderating influence is shown by the average temperature of 50° at Richmond and 46° at Antioch. Table 9 shows average monthly and annual temperatures for several locations in Contra Costa County.

In most of the county, the average period when the daily minimum temperature stays above 32° lasts for most of the year. It ranges in length from 365 days near the bay shore to 266 days at Antioch.

There is an average of about 3,000 hours of sunshine per year. In January the sun shines about 50 percent of the daytime, and in July it shines about 75 percent of the daytime. In December and January, tule fog is common and may last for several days. Frequently this fog drifts into the small inland valleys. Late in spring and in summer, coastal fog is common in areas adjacent to San Pablo Bay. It usually clears late in the morning.

Average annual precipitation ranges from 13.34 inches in Antioch to 22.77 inches at Mount Diablo, North Gate, and 22.28 inches at Richmond. The differences reflect elevation or proximity to the coast. Table 10 shows the average monthly and annual precipitation for several locations in Contra Costa County.

Snow commonly does not fall on the lowlands, but brief, heavy falls occur at higher elevations. Snow is common on Mount Diablo and falls occasionally on the lower lying foothills. It remains on the north slopes of Mount Diablo for as long as two to three days.

In winter the relative humidity averages about 90 percent at night and about 70 percent in the afternoon. In July the relative humidity averages about 75 percent in the morning; it drops to 55 percent in the afternoon where there is an influx of marine air and to about 35 percent in the dry interior. At times dry north winds cause the humidity to drop below 10 percent. These are most frequent in September.

Water Supply

Contra Costa County has two main sources of fresh water. Irrigation water is pumped from the sloughs of the delta. A large part of the domestic water for central and eastern Contra Costa County is also obtained from the delta sloughs. Domestic water for the western part and areas in the central part of the county is imported from Pardee and Commanche Reservoirs in the foothills of the Sierra mountains.

TABLE 9.—*Mean temperatures*

Month	Location					
	Antioch Fibreboard Mills	Livermore	Martinez Fire Station	Mt. Diablo (North Gate)	Richmond	Walnut Creek
	°F	°F	°F	°F	°F	°F
January	45.7	46.1	46.4	46.1	50.2	45.5
February	49.8	49.0	50.1	48.3	52.9	48.8
March	53.9	52.4	53.7	49.3	54.6	51.6
April	59.2	56.9	58.1	54.3	57.4	56.7
May	64.9	61.9	61.9	58.1	60.6	60.8
June	70.7	67.0	67.5	65.2	62.8	66.1
July	74.0	71.7	70.3	74.3	62.0	70.6
August	72.3	70.8	69.2	72.2	62.2	69.9
September	70.6	69.5	68.6	70.6	65.0	69.1
October	63.2	62.6	62.4	63.0	62.4	62.2
November	53.4	53.4	53.9	54.5	56.1	52.9
December	47.0	47.5	47.7	50.0	51.7	46.7
Annual	60.4	59.1	59.2	58.8	58.2	58.4

TABLE 10.—*Total precipitation*

Month	Location					
	Antioch Fibreboard Mills	Livermore	Martinez Fire Station	Mt. Diablo (North Gate)	Richmond	Walnut Creek
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
January	2.70	3.01	3.76	5.19	5.27	4.35
February	2.42	2.67	3.38	4.24	3.61	3.66
March	1.95	1.94	2.55	2.44	2.44	2.61
April	1.05	1.13	1.20	2.23	1.95	1.33
May	.47	.49	.55	.99	.66	.63
June	.09	.10	.11	.21	.12	.10
July	.01	.01	.01	(1)	(1)	(1)
August	.02	.02	.02	.03	.04	.05
September	.14	.12	.17	.43	.50	.29
October	.56	.59	.71	.69	.72	.86
November	1.14	1.46	1.49	1.82	1.76	2.02
December	2.79	2.86	3.54	4.50	4.98	3.97
Annual	13.34	14.40	17.49	22.77	22.05	19.87

[1] Trace.

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Glossary

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low available water capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state. In engineering, a high liquid limit indicates that the soil has a high content of clay and a low capacity for supporting loads.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Parent material. Disintegrated and partly weathered rock from which soil has formed.

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Plasticity index. The numerical difference betweeen the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from a semisolid to a plastic state.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Series, soil. A group of soils developed from a particular type of parent material and having genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the profile.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Substratum. Technically, the part of the soil below the solum.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Topsoil. A presumed fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which it belongs. For information about the capability grouping system, see the section beginning on page 55. For information about the Storie index ratings, see the section beginning on page 66.

Map symbol	Mapping unit	Page	Capability unit		Range site		Storie index rating
			Symbol	Page	Name	Page	
AaE	Alo clay, 15 to 30 percent slopes	7	IVe-5(15)	61	Clayey	69	23
AaF	Alo clay, 30 to 50 percent slopes	9	VIe-1(15)	62	Clayey, steep	69	12
AaG	Alo clay, 50 to 75 percent slopes	9	VIIe-1(15)	62	Clayey, very steep	69	6
AbD	Altamont clay, 9 to 15 percent slopes	9	IIIe-5(15)	59	Clayey	69	36
AbE	Altamont clay, 15 to 30 percent slopes	10	IVe-5(15)	61	Clayey	69	27
AcF	Altamont-Fontana complex, 30 to 50 percent slopes	10	VIe-1(15)	62	Clayey, steep	69	19
AcG	Altamont-Fontana complex, 50 to 75 percent slopes	10	VIIe-1(15)	62	Clayey, very steep	69	9
AdA	Antioch loam, 0 to 2 percent slopes	11	IIIs-3(17)	60	Claypan	71	38
AdC	Antioch loam, 2 to 9 percent slopes	11	IVe-3(15)	61	Claypan	71	36
BaA	Botella clay loam, 0 to 2 percent slopes	11	I(17)	56	----------	--	81
BaC	Botella clay loam, 2 to 9 percent slopes	12	IIe-1(17)	57	----------	--	77
Bb	Brentwood clay loam	13	I(17)	56	----------	--	81
Bc	Brentwood clay loam, wet	13	IIw-2(17)	58	----------	--	65
BdE	Briones loamy sand, 5 to 30 percent slopes	13	VIe-1(15)	62	Sandy	70	38
BdE2	Briones loamy sand, 15 to 30 percent slopes, eroded	14	VIIe-1(15)	62	Sandy	70	20
BdF	Briones loamy sand, 30 to 50 percent slopes	14	VIIe-1(15)	62	Sandy, steep	70	16
BdF2	Briones loamy sand, 30 to 50 percent slopes, eroded	14	VIIe-1(15)	62	Sandy, steep	70	11
BeB	Briones fine sandy loam, 2 to 5 percent slopes	14	IIIs-4(17)	60	----------	--	65
CaA	Capay clay, 0 to 2 percent slopes	15	IIs-5(17)	58	----------	--	54
CaC	Capay clay, 2 to 9 percent slopes	15	IIe-3(17)	57	----------	--	51
CbA	Capay clay, wet, 0 to 2 percent slopes	16	IIw-5(17)	58	----------	--	43
Cc	Clear Lake clay	16	IIs-5(17)	58	----------	--	49
CeA	Conejo clay loam, 0 to 2 percent slopes	17	I(17)	56	----------	--	85
CeB	Conejo clay loam, 2 to 5 percent slopes	17	IIe-1(17)	57	----------	--	81
ChA	Conejo clay loam, clay substratum, 0 to 2 percent slopes	17	IIs-3(17)	58	----------	--	68
CkB	Cropley clay, 2 to 5 percent slopes	18	IIe-5(17)	57	----------	--	51
CmE	Cut and fill land-Diablo complex, 9 to 30 percent slopes	18	----------	--	----------	--	--
CnE	Cut and fill land-Los Osos complex, 9 to 30 percent slopes	19	----------	--	----------	--	--
CoE	Cut and fill land-Millsholm complex, 9 to 30 percent slopes	19	----------	--	----------	--	--
CoF	Cut and fill land-Millsholm complex, 30 to 50 percent slopes	19	----------	--	----------	--	--
DaC	Delhi sand, 2 to 9 percent slopes	20	IIIs-4(17)	60	----------	--	49
DdD	Diablo clay, 9 to 15 percent slopes	21	IIIe-5(15)	59	Clayey	69	36
DdE	Diablo clay, 15 to 30 percent slopes	21	IVe-5(15)	61	Clayey	69	27
DdF	Diablo clay, 30 to 50 percent slopes	21	VIe-1(15)	62	Clayey, steep	69	17
DeE	Dibble silty clay loam, 15 to 30 percent slopes	22	IVe-3(15)	61	Loamy	70	36
DeF	Dibble silty clay loam, 30 to 50 percent slopes	22	VIe-1(15)	62	Loamy, steep	70	22
Ea	Egbert mucky clay loam	23	IIIw-2(16)	59	----------	--	32
FaG	Felton loam, 50 to 75 percent slopes	24	VIIe-1(15)	62	----------	--	14
Fc	Fluvaquents	24	VIIIw-1(16)	63	----------	--	<10
Fd	Fontana-Altamont complex	24	IVe-5(15)	61	Clayey	69	32
GaA	Garretson loam, 0 to 2 percent slopes	25	I(17)	56	----------	--	100
GaB	Garretson loam, 2 to 5 percent slopes	25	IIe-1(17)	57	----------	--	95
GbE	Gaviota sandy loam, 15 to 30 percent slopes	26	VIIe-1(15)	62	Shallow Coarse Loamy	71	23

Map symbol	Mapping unit	Page	Capability unit		Range site		Storie index rating
			Symbol	Page	Name	Page	
GbF	Gaviota sandy loam, 30 to 50 percent slopes--	26	VIIe-1(15)	62	Shallow Coarse Loamy	71	14
GbG	Gaviota sandy loam, 50 to 75 percent slopes--	26	VIIe-1(15)	62	Shallow Coarse Loamy, steep	71	7
GcE	Gilroy clay loam, 15 to 30 percent slopes-----	26	IVe-1(15)	61	Loamy	70	35
GcF	Gilroy clay loam, 30 to 50 percent slopes----	26	VIe-1(15)	62	Loamy, steep	70	22
GcG	Gilroy clay loam, 50 to 75 percent slopes----	26	VIIe-1(15)	62	Loamy, very steep	70	9
Ja	Joice muck----------	27	VIw-1(16)	62	----------	--	5
KaC	Kimball gravelly clay loam, 2 to 9 percent slopes----------	28	IVe-3(15)	61	Claypan	71	32
KaE	Kimball gravelly clay loam, 9 to 30 percent slopes----------	28	VIe-1(15)	62	Claypan	71	27
Kb	Kingile muck----------	29	IIIw-10(16)	59	----------	--	32
La	Laugenour loam----------	30	IIs-0(17)	58	----------	--	77
LbD	Linne clay loam, 5 to 15 percent slopes------	30	IIIe-5(15)	59	Clayey	69	43
LbE	Linne clay loam, 15 to 30 percent slopes-----	30	IVe-1(15)	61	Clayey	69	33
LcE	Lodo clay loam, 9 to 30 percent slopes-------	31	VIe-1(15)	62	Shallow Fine Loamy	71	27
LcF	Lodo clay loam, 30 to 50 percent slopes------	31	VIIe-1(15)	62	Shallow Fine Loamy, steep	71	14
LcG	Lodo clay loam, 50 to 75 percent slopes------	31	VIIe-1(15)	62	Shallow Fine Loamy, very steep	71	7
Ld	Lodo-Rock outcrop complex----------	31	VIIe-1(15)	62	Shallow Fine Loamy, very steep	71	2-13
LeE	Los Gatos loam, 15 to 30 percent slopes------	32	IVe-1(15)	61	Loamy	70	37
LeF	Los Gatos loam, 30 to 50 percent slopes------	32	VIe-1(15)	62	Loamy, steep	70	23
LeG	Los Gatos loam, 50 to 75 percent slopes------	32	VIIe-1(15)	62	Loamy, very steep	70	11
LhE	Los Osos clay loam, 15 to 30 percent slopes--	33	IVe-3(15)	61	Fine Loamy	70	30
LhF	Los Osos clay loam, 30 to 50 percent slopes--	33	VIe-1(15)	62	Fine Loamy, steep	70	19
LhG	Los Osos clay loam, 50 to 75 percent slopes--	33	VIIe-1(15)	62	Fine Loamy, very steep	70	9
Lk	Los Osos-Los Gatos complex----------	33	VIIe-1(15)	62	Fine Loamy, very steep	70	10
Lm	Los Robles clay loam----------	34	I(17)	56	----------	--	81
Ma	Marcuse sand----------	34	IVw-6(17)	62	----------	--	23
Mb	Marcuse clay----------	35	IVw-6(17)	62	----------	--	16
Mc	Marcuse clay, strongly alkali----------	35	VIw-1(17)	62	----------	--	8
Md	Merritt loam----------	35	IIIw-2(16)	59	----------	--	60
MeE	Millsholm loam, 15 to 30 percent slopes------	36	VIe-1(15)	62	Shallow Fine Loamy	71	25
MeF	Millsholm loam, 30 to 50 percent slopes------	36	VIIe-1(15)	62	Shallow Fine Loamy, steep	71	15
MeG	Millsholm loam, 50 to 75 percent slopes------	36	VIIe-1(15)	62	Shallow Fine Loamy, very steep	71	8
Oa	Omni clay loam----------	37	IIw-2(17)	58	----------	--	61
Ob	Omni silty clay----------	37	IVw-6(17)	62	----------	--	25
PaC	Perkins gravelly loam, 2 to 9 percent slopes-	38	IIIe-3(15)	59	Claypan	71	44
PaD	Perkins gravelly loam, 9 to 15 percent slopes----------	38	IVe-3(15)	61	Claypan	71	39
Pb	Pescadero clay loam----------	39	IVw-6(17)	62	----------	--	27
Pc	Pescadero clay loam, strongly alkali---------	39	VIw-1(17)	62	----------	--	20
Pd	Piper sand----------	40	IVw-4(16)	61	----------	--	36
Pe	Piper loamy sand----------	40	IVw-4(16)	61	----------	--	32
Ph	Piper fine sandy loam----------	40	IVe-9(16)	61	----------	--	23
PkA	Positas loam, 0 to 2 percent slopes----------	41	IIIs-3(17)	60	Claypan	71	52
PkC	Positas loam, 2 to 9 percent slopes----------	41	IVe-3(15)	61	Claypan	71	50
Qa	Quarry----------	41	VIIIe-1(15)	63	----------	--	<10
Ra	Reyes silty clay----------	42	VIIIw-1(16)	63	----------	--	6
RbA	Rincon clay loam, 0 to 2 percent slopes------	42	IIs-3(17)	58	----------	--	68
RbC	Rincon clay loam, 2 to 9 percent slopes------	42	IIe-3(17)	57	----------	--	65
RbD	Rincon clay loam, 9 to 15 percent slopes-----	43	IIe-3(17)	57	----------	--	61
RcA	Rincon clay loam, wet, 0 to 2 percent slopes-	43	IIw-2(17)	58	----------	--	54
Rd	Rindge muck----------	43	IIIw-10(16)	59	----------	--	40

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit Symbol	Page	Range site Name	Page	Storie index rating
Re	Rock outcrop-Xerorthents association----------	44	VIIIe-1(15)	63	----------	--	<10
Rh	Ryde silt loam----------	44	IIIw-2(16)	59	----------	--	50
Sa	Sacramento clay----------	45	IIIw-5(16)	59	----------	--	49
Sb	Sacramento clay, alkali----------	45	IVw-6(17)	62	----------	--	39
Sc	San Ysidro loam----------	46	IIIs-3(17)	60	Claypan	71	43
SdE	Sehorn clay, 15 to 30 percent slopes----------	47	IVe-5(15)	61	Clayey	69	27
SdF	Sehorn clay, 30 to 50 percent slopes----------	47	VIe-1(15)	62	Clayey, steep	69	17
SdG	Sehorn clay, 50 to 75 percent slopes----------	47	VIIe-1(15)	62	Clayey, very steep	69	7
Se	Shima muck----------	48	IIIw-10(16)	59	----------	--	32
Sh	Solano loam----------	49	IVw-6(17)	62	----------	--	23
Sk	Solano loam, strongly alkali----------	49	VIw-1(17)	62	----------	--	17
Sm	Sorrento silty clay loam----------	49	I(17)	56	----------	--	90
Sn	Sorrento silty clay loam, sand substratum-----	49	IIs-0(17)	58	----------	--	72
So	Sycamore silty clay loam----------	50	I(17)	56	----------	--	81
Sp	Sycamore silty clay loam, clay substratum-----	51	IIw-2(17)	58	----------	--	77
TaC	Tierra loam, 2 to 9 percent slopes----------	51	IVe-3(15)	61	Claypan	71	49
TaD	Tierra loam, 9 to 15 percent slopes----------	51	IVe-3(15)	61	Claypan	71	44
TaE	Tierra loam, 15 to 30 percent slopes----------	52	VIe-1(15)	62	Claypan	71	33
Ub	Urban land----------	52	----------	--	----------	--	<10
VaF	Vallecitos loam, 30 to 50 percent slopes------	52	VIIe-1(15)	62	Loamy	70	13
Vb	Venice muck----------	53	IIIw-10(16)	59	----------	--	40
Wa	Webile muck----------	54	IIIw-10(16)	59	----------	--	32
ZaA	Zamora silty clay loam, 0 to 2 percent slopes-	54	I(17)	56	----------	--	86
ZaB	Zamora silty clay loam, 2 to 5 percent slopes-	54	IIe-1(17)	57	----------	--	81

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U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
UNIVERSITY OF CALIFORNIA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

CONTRA COSTA COUNTY, CALIFORNIA

Scale 1:253,440
1 0 1 2 3 4 Miles

SOIL ASSOCIATIONS*

NEARLY LEVEL TO STRONGLY SLOPING, SOMEWHAT EXCESSIVELY DRAINED TO VERY POORLY DRAINED SOILS ON VALLEY FILL, BASINS, LOW TERRACES, FLOOD PLAINS, AND ALLUVIAL FANS

1. Brentwood-Rincon-Zamora association: Nearly level to gently sloping, well-drained clay loams and silty clay loams on valley fill, alluvial fans, and low terraces
2. Capay-Sycamore-Brentwood association: Nearly level, moderately well drained, poorly drained, and well drained clays, silty clay loams, and clay loams on valley fill and flood plains
3. Capay-Rincon association: Nearly level to strongly sloping, moderately well drained and well drained clays and clay loams on valley fill
4. Delhi association: Gently sloping and moderately sloping, somewhat excessively drained sands in the valleys
5. Clear Lake-Cropley association: Nearly level to gently sloping, poorly drained and moderately well drained clays on valley fill and in coastal valley basins
6. Marcuse-Solano-Pescadero association: Nearly level, very poorly drained to somewhat poorly drained clays, loams, and clay loams on rims of basins

NEARLY LEVEL, POORLY DRAINED AND VERY POORLY DRAINED SOILS ON THE DELTA, FLOOD PLAINS, AND SALTWATER MARSHES AND TIDAL FLATS

7. Rindge-Kingile association: Nearly level, very poorly drained mucks on the delta
8. Sacramento-Omni association: Nearly level, poorly drained and very poorly drained clays and clay loams on the delta and on flood plains
9. Joice-Reyes association: Nearly level, very poorly drained, saline mucks and silty clays on saltwater marshes and tidal flats

NEARLY LEVEL TO VERY STEEP, MODERATELY WELL DRAINED TO EXCESSIVELY DRAINED SOILS ON TERRACES AND MOUNTAINOUS UPLANDS

10. Tierra-Antioch-Perkins association: Nearly level to moderately step, moderately well drained and well drained loams and clay loams that formed in old alluvium on terraces
11. Altamont-Diablo-Fontana association: Strongly sloping to very steep, well-drained clays and silty clay loams that formed in material weathered from soft, fine-grained sandstone and shale on uplands
12. Los Osos-Millsholm-Los Gatos association: Moderately steep to very steep, well-drained clay loams and loams that formed in material weathered from interbedded sedimentary rock on uplands
13. Gilroy-Vallecitos association: Moderately steep to very steep, well-drained clay loams and loams that formed in material weathered from basic igneous rock and metasedimentary rock on uplands
14. Rock outcrop-Xerorthent association: Steep to very steep areas of rock outcrop and excessively drained, very shallow, loamy soils that formed in material weathered from sedimentary rock and basic igneous rock on uplands

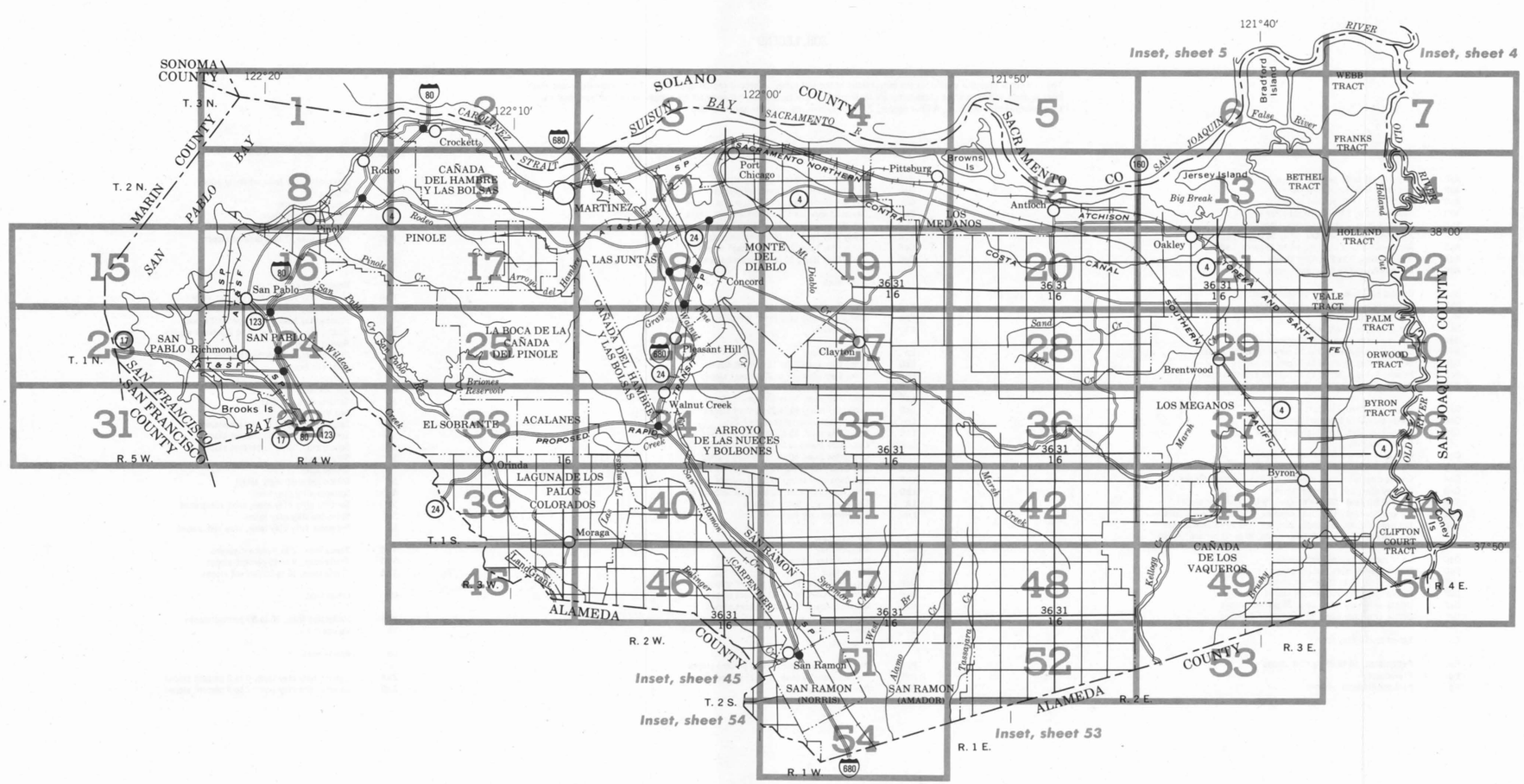
*Unless otherwise stated, the terms for texture used in the description of the association apply to the surface layer of the major soils.

Compiled 1976

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



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INDEX TO MAP SHEETS

CONTRA COSTA COUNTY, CALIFORNIA

Scale 1:253,440

1 0 1 2 3 4 Miles

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

CONTRA COSTA COUNTY, CALIFORNIA

MODAL SITE

SOIL SERIES	SHEET NO.	PART OF SHEET
1. Alo	47	N Central
2. Altamont	43	S Central
3. Antioch	3	SE Corner
4. Botella	51	W Central
5. Brentwood	37	N Side
6. Briones	37	NW Corner
7. Capay	21	W Side
8. Clear Lake	51	NW Central
9. Conejo	47	SW Corner
10. Cropley	10	NE Central
11. Delhi	21	E Central
12. Diablo	51	E Central
13. Dibble	41	E Central
14. Egbert	38	NW Corner
15. Felton	45	NE Central
16. Fontana	49	NE Corner
17. Garretson	27	W Side
18. Gaviota	34	NE Corner
19. Gilroy	27	SW Central
20. Joice	11	N Side
21. Kimball	29	W Side
22. Kingile	38	SW Corner
23. Laugenour	18	S Side
24. Linne	43	S Central
25. Lodo	40	E Side
26. Los Gatos	42	N Side
27. Los Osos	40	NW Corner
28. Los Robles	27	NW Corner
29. Marcuse	38	NW Corner
30. Merrit 1/	5	SW Corner
31. Millsholm	17	SW Corner
32. Omni	10	W Central
33. Perkins	27	S Central
34. Pescadero	54	N Side
35. Piper	13	E Side
36. Positas	13	SE Corner
37. Reyes	16	W Side
38. Rincon	29	NW Corner
39. Rindge	22	S Side
40. Ryde	22	W Side
41. Sacramento	44	NW Corner
42. San Ysidro	50	W Central
43. Sehorn	46	NW Corner
44. Shima	22	W Side
45. Solano	50	NW Central
46. Sorrento	36	NW Corner
47. Sycamore	21	N Central
48. Tierra	51	SW Corner
49. Vallecitos	41	N Side
50. Venice	6	SE Central
51. Webile	38	N Side
52. Zamora	34	NE Corner

1/ Location for Merrit series is on inset on sheet 5.

CONTRA COSTRA COUNTY, CALIFORNIA

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Divided
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State or county

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail
- Railroad
- Ferry (FY)
- Ford (FORD)
- Grade
- R. R. over
- R. R. under

Buildings
- School
- Church

Mine and quarry (OU.)

Gravel pit

Power line

Pipeline

Cemetery

Dams

Levee

Tanks

Well, oil or gas

Forest fire or lookout station

Windmill

Located object

BOUNDARIES

- National or state
- County
- Limit of soil survey
- Reservation
- Land grant
- Small park, cemetery, airport
- Land survey division corners

DRAINAGE

Streams, double-line
- Perennial
- Intermittent

Streams, single-line
- Perennial
- Intermittent
  - Crossable with tillage implements
  - Not crossable with tillage implements
- Unclassified

Canals and ditches unclassified

Lakes and ponds
- Perennial (water, w)
- Intermittent (int)

Spring

Marsh or swamp

Wet spot

Drainage end or alluvial fan

RELIEF

Escarpments
- Bedrock
- Other

Short steep slope

Prominent peak

Depressions

	Large	Small
Crossable with tillage implements		
Not crossable with tillage implements		
Contains water most of the time		

SOIL SURVEY DATA

- Soil boundary and symbol (Dx)
- Gravel
- Stoniness: Stony, Very stony
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gully
- Saline spot
- Soil sample site (S)

SOIL LEGEND

The first letter always a capital, is the initial letter of the soil name. A second capital letter A, B, C etc., indicates slope class. Most symbols without a slope class letter are for those of nearly level soils, but some are for complexes or land types that have a considerable range in slope. A final number, 2, in the symbol indicates the soil is eroded.

SYMBOL	NAME
AaE	Alo clay, 15 to 30 percent slopes
AaF	Alo clay, 30 to 50 percent slopes
AaG	Alo clay, 50 to 75 percent slopes
AbD	Altamont clay, 9 to 15 percent slopes
AbE	Altamont clay, 15 to 30 percent slopes
AcF	Altamont-Fontana complex, 30 to 50 percent slopes
AcG	Altamont-Fontana complex, 50 to 75 percent slopes
AdA	Antioch loam, 0 to 2 percent slopes
AdC	Antioch loam, 2 to 9 percent slopes
BaA	Botella clay loam, 0 to 2 percent slopes
BaC	Botella clay loam, 2 to 9 percent slopes
Bb	Brentwood clay loam
Bc	Brentwood clay loam, wet
BdE	Briones loamy sand, 5 to 30 percent slopes
BdE2	Briones loamy sand, 15 to 30 percent slopes, eroded
BdF	Briones loamy sand, 30 to 50 percent slopes
BdF2	Briones loamy sand, 30 to 50 percent slopes, eroded
BeB	Briones fine sandy loam, 2 to 5 percent slopes
CaA	Capay clay, 0 to 2 percent slopes
CaC	Capay clay, 2 to 9 percent slopes
CbA	Capay clay, wet, 0 to 2 percent slopes
Cc	Clear Lake clay
CeA	Conejo clay loam, 0 to 2 percent slopes
CeB	Conejo clay loam, 2 to 5 percent slopes
ChA	Conejo clay loam, clay substratum, 0 to 2 percent slopes
CkB	Cropley clay, 2 to 5 percent slopes
CmE	Cut and fill land - Diablo complex, 9 to 30 percent slopes
CnE	Cut and fill land - Los Osos complex, 9 to 30 percent slopes
CoE	Cut and fill land - Millsholm complex, 9 to 30 percent slopes
CoF	Cut and fill land - Millsholm complex, 30 to 50 percent slopes
DaC	Delhi sand, 2 to 9 percent slopes
DdD	Diablo clay, 9 to 15 percent slopes
DdE	Diablo clay, 15 to 30 percent slopes
DdF	Diablo clay, 30 to 50 percent slopes
DeE	Dibble silty clay loam, 15 to 30 percent slopes
DeF	Dibble silty clay loam, 30 to 50 percent slopes
Ea	Egbert mucky clay loam
FaG	Felton loam, 50 to 75 percent slopes
Fc	Fluvaquents
Fd	Fontana-Altamont complex
GaA	Garretson loam, 0 to 2 percent slopes
GaB	Garretson loam, 2 to 5 percent slopes
GbE	Gaviota sandy loam, 15 to 30 percent slopes
GbF	Gaviota sandy loam, 30 to 50 percent slopes
GbG	Gaviota sandy loam, 50 to 75 percent slopes
GcE	Gilroy clay loam, 15 to 30 percent slopes
GcF	Gilroy clay loam, 30 to 50 percent slopes
GcG	Gilroy clay loam, 50 to 75 percent slopes
Ja	Joice muck
KaC	Kimball gravelly clay loam, 2 to 9 percent slopes
KaE	Kimball gravelly clay loam, 9 to 30 percent slopes
Kb	Kingile muck
La	Laugenour loam
LbD	Linne clay loam, 5 to 15 percent slopes
LbE	Linne clay loam, 15 to 30 percent slopes
LcE	Lodo clay loam, 9 to 30 percent slopes
LcF	Lodo clay loam, 30 to 50 percent slopes
LcG	Lodo clay loam, 50 to 75 percent slopes
Ld	Lodo - Rock outcrop complex
LeE	Los Gatos loam, 15 to 30 percent slopes
LeF	Los Gatos loam, 30 to 50 percent slopes
LeG	Los Gatos loam, 50 to 75 percent slopes
LhE	Los Osos clay loam, 15 to 30 percent slopes
LhF	Los Osos clay loam, 30 to 50 percent slopes
LhG	Los Osos clay loam, 50 to 75 percent slopes
Lk	Los Osos - Los Gatos complex
Lm	Los Robles clay loam
Ma	Marcuse sand
Mb	Marcuse clay
Mc	Marcuse clay, strongly alkali
Md	Merritt loam
MeE	Millsholm loam, 15 to 30 percent slopes
MeF	Millsholm loam, 30 to 50 percent slopes
MeG	Millsholm loam, 50 to 75 percent slopes
Oa	Omni clay loam
Ob	Omni silty clay
PaC	Perkins gravelly loam, 2 to 9 percent slopes
PaD	Perkins gravelly loam, 9 to 15 percent slopes
Pb	Pescadero clay loam
Pc	Pescadero clay loam, strongly alkali
Pd	Piper sand
Pe	Piper loamy sand
Ph	Piper fine sandy loam
PkA	Positas loam, 0 to 2 percent slopes
PkC	Positas loam, 2 to 9 percent slopes
Qa	Quarry
Ra	Reyes silty clay
RbA	Rincon clay loam, 0 to 2 percent slopes
RbC	Rincon clay loam, 2 to 9 percent slopes
RbD	Rincon clay loam, 9 to 15 percent slopes
RcA	Rincon clay loam, wet, 0 to 2 percent slopes
Rd	Rindge muck
Re	Rock outcrop - Xerorthents association
Rh	Ryde silt loam
Sa	Sacramento clay
Sb	Sacramento clay, alkali
Sc	San Ysidro loam
SdE	Sehorn clay, 15 to 30 percent slopes
SdF	Sehorn clay, 30 to 50 percent slopes
SdG	Sehorn clay, 50 to 75 percent slopes
Se	Shima muck
Sh	Solano loam
Sk	Solano loam, strongly alkali
Sm	Sorrento silty clay loam
Sn	Sorrento silty clay loam, sand substratum
So	Sycamore silty clay loam
Sp	Sycamore silty clay loam, clay substratum
TaC	Tierra loam, 2 to 9 percent slopes
TaD	Tierra loam, 9 to 15 percent slopes
TaE	Tierra loam, 15 to 30 percent slopes
Ub	Urban land
VaF	Vallecitos loam, 30 to 50 percent slopes
Vb	Venice muck
Wa	Webile muck
ZaA	Zamora silty clay loam, 0 to 2 percent slopes
ZaB	Zamora silty clay loam, 2 to 5 percent slopes

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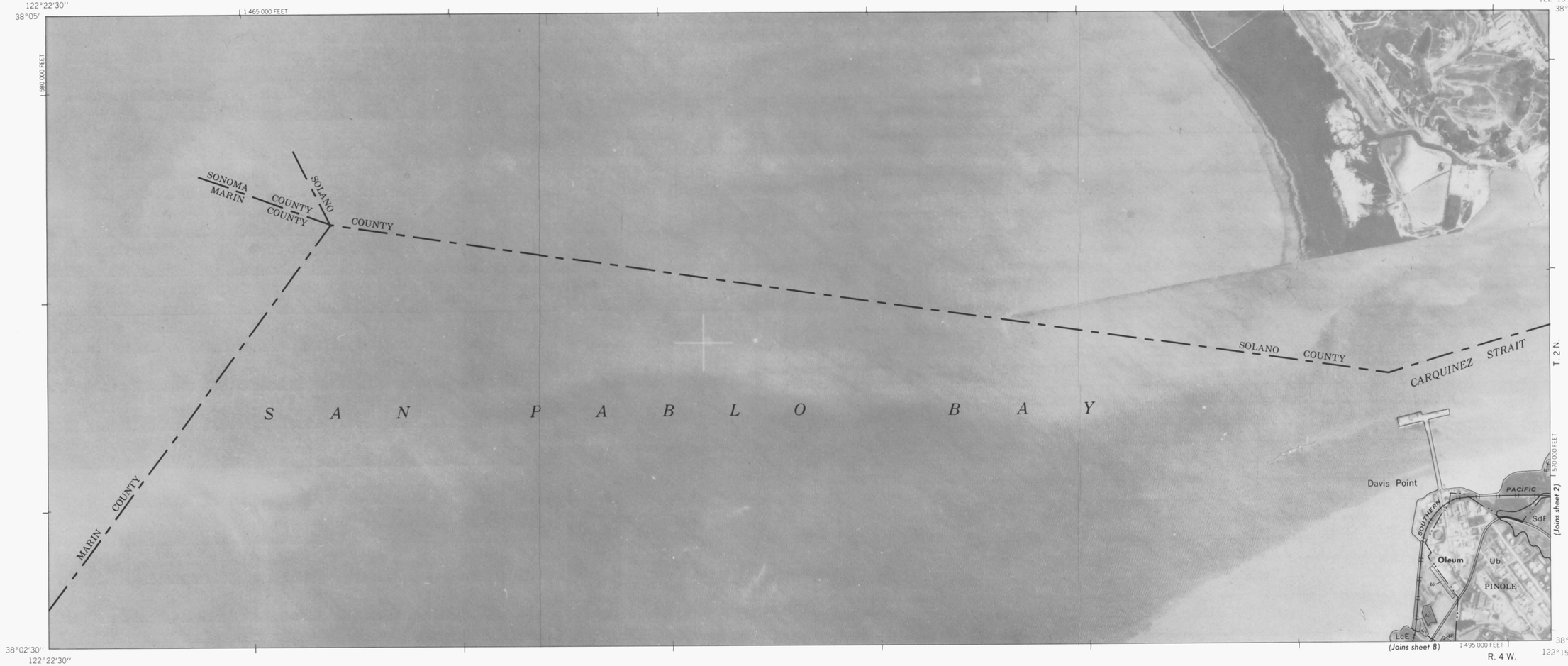
Land division corners are approximately positioned on this map.



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1 ¾ ½ ¼ 0 1 2 Miles

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Scale 1:24000

CONTRA COSTA COUNTY AREA, CALIFORNIA — SHEET NUMBER 2

1 ¾ ½ ¼ 0 1 2 Miles

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Scale 1:24000

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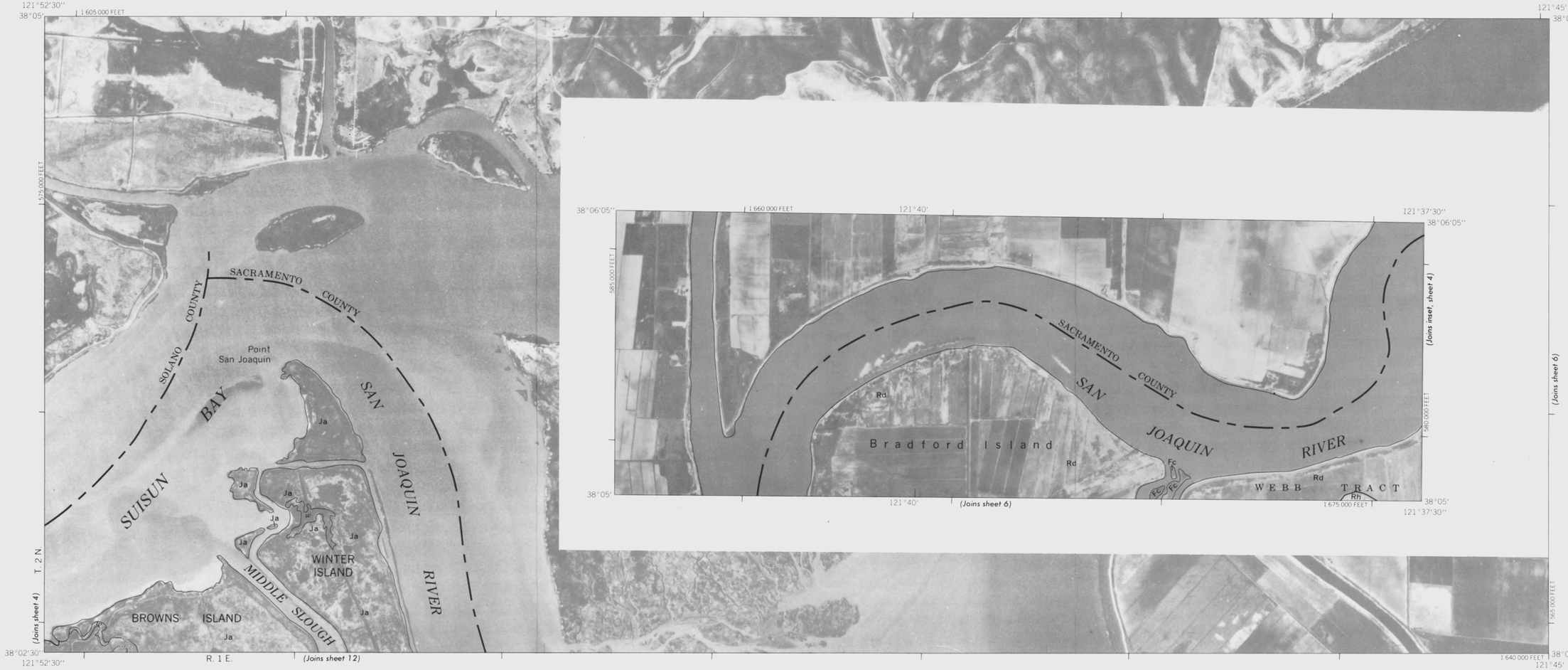
CONTRA COSTA COUNTY, CALIFORNIA NO. 4



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Scale 1:24 000

1 ¾ ½ ¼ 0 1 2 Miles

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Scale 1:24000

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CONTRA COSTA COUNTY, CALIFORNIA NO. 6

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Scale 1:24000

1 3/4 1/2 3/4 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000

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CONTRA COSTA COUNTY, CALIFORNIA NO. 8

CONTRA COSTA COUNTY, CALIFORNIA NO. 9

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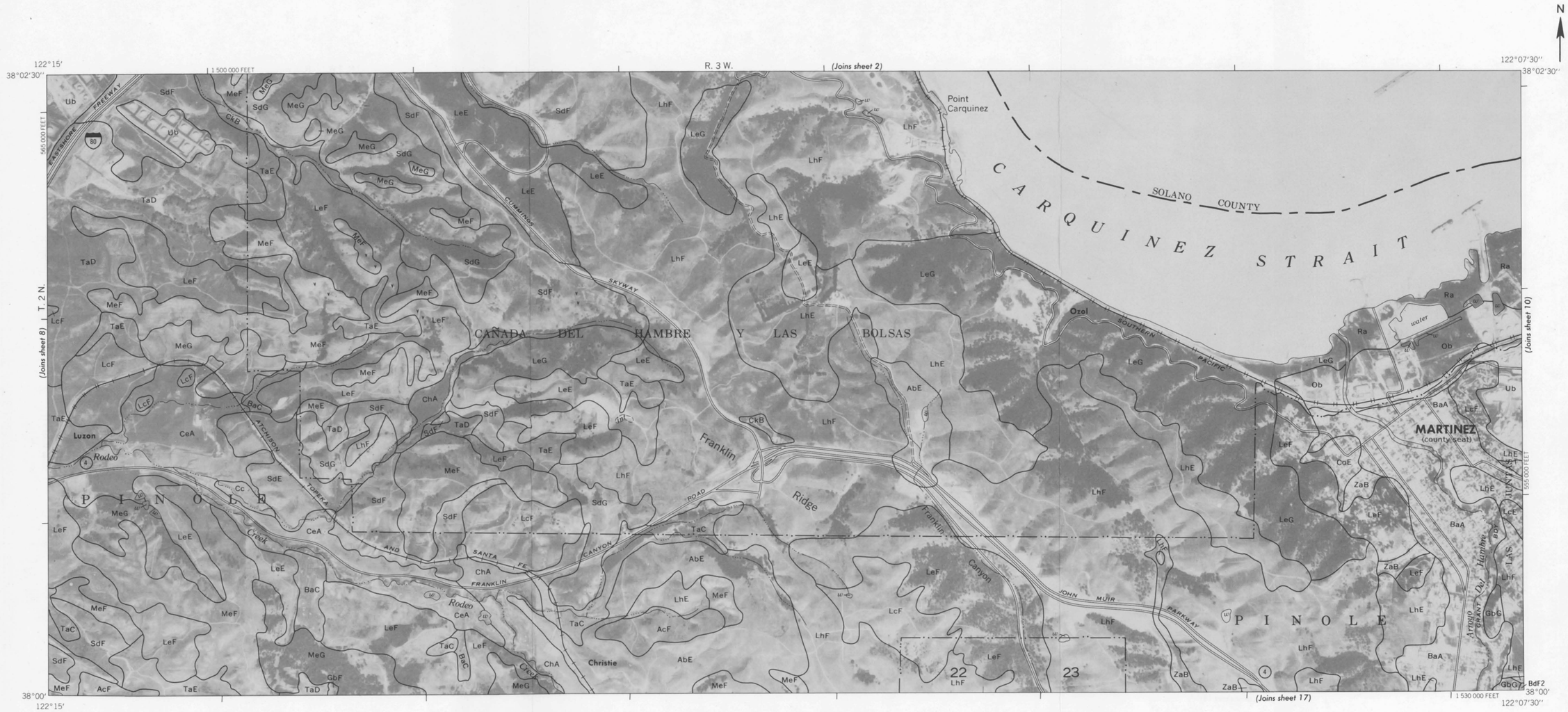

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Scale 1:24000

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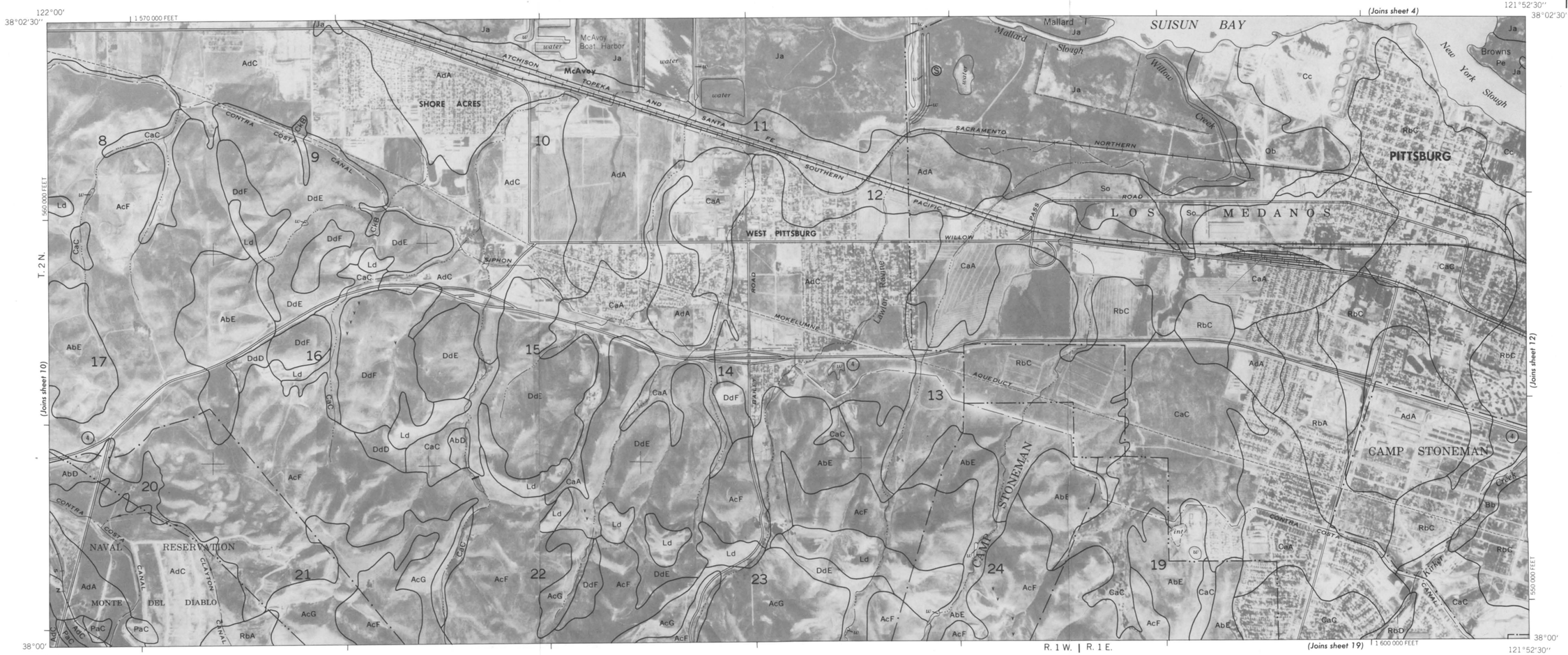

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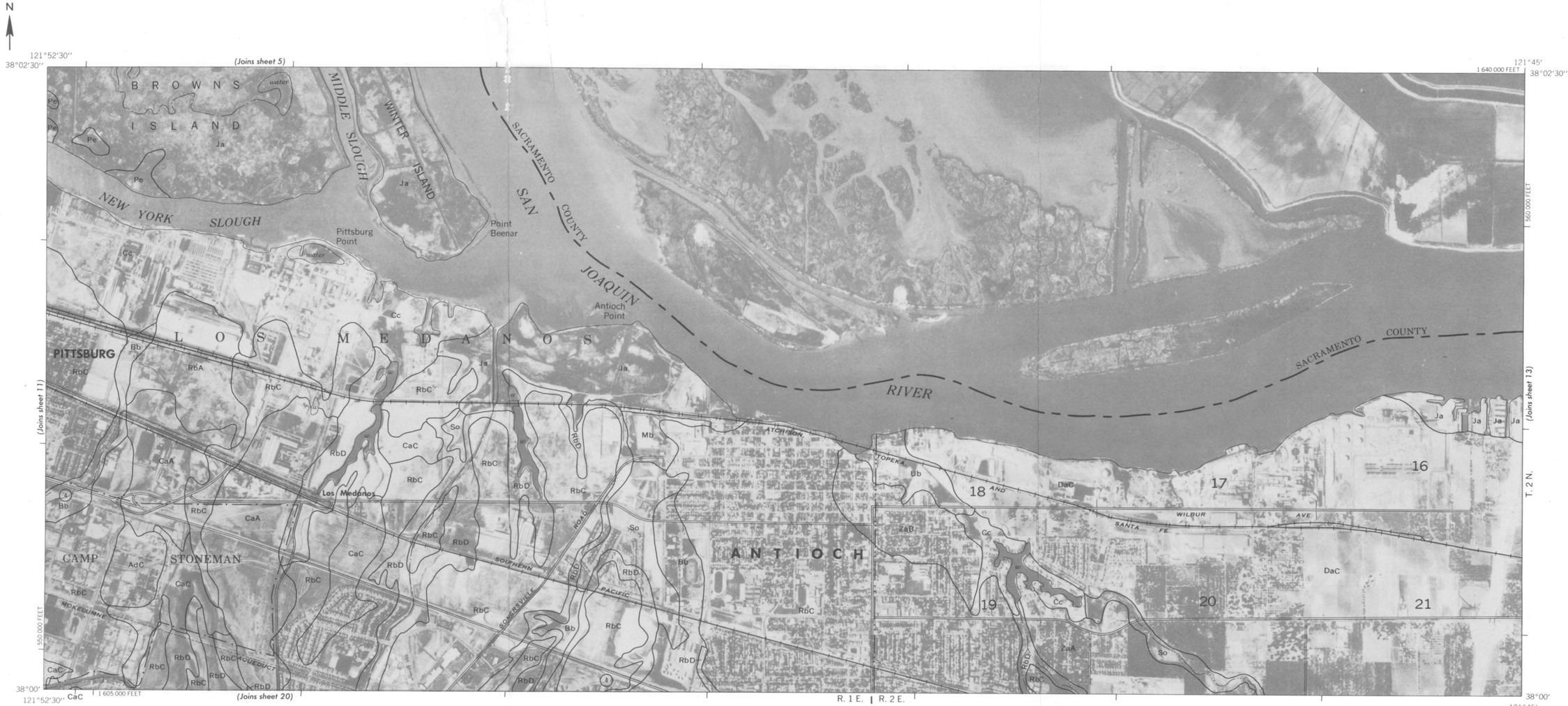

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CONTRA COSTA COUNTY, CALIFORNIA NO. 12

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1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000

1 1¾ 1½ 1¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000

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Land division corners are approximately positioned on this map.

CONTRA COSTA COUNTY, CALIFORNIA NO. 14

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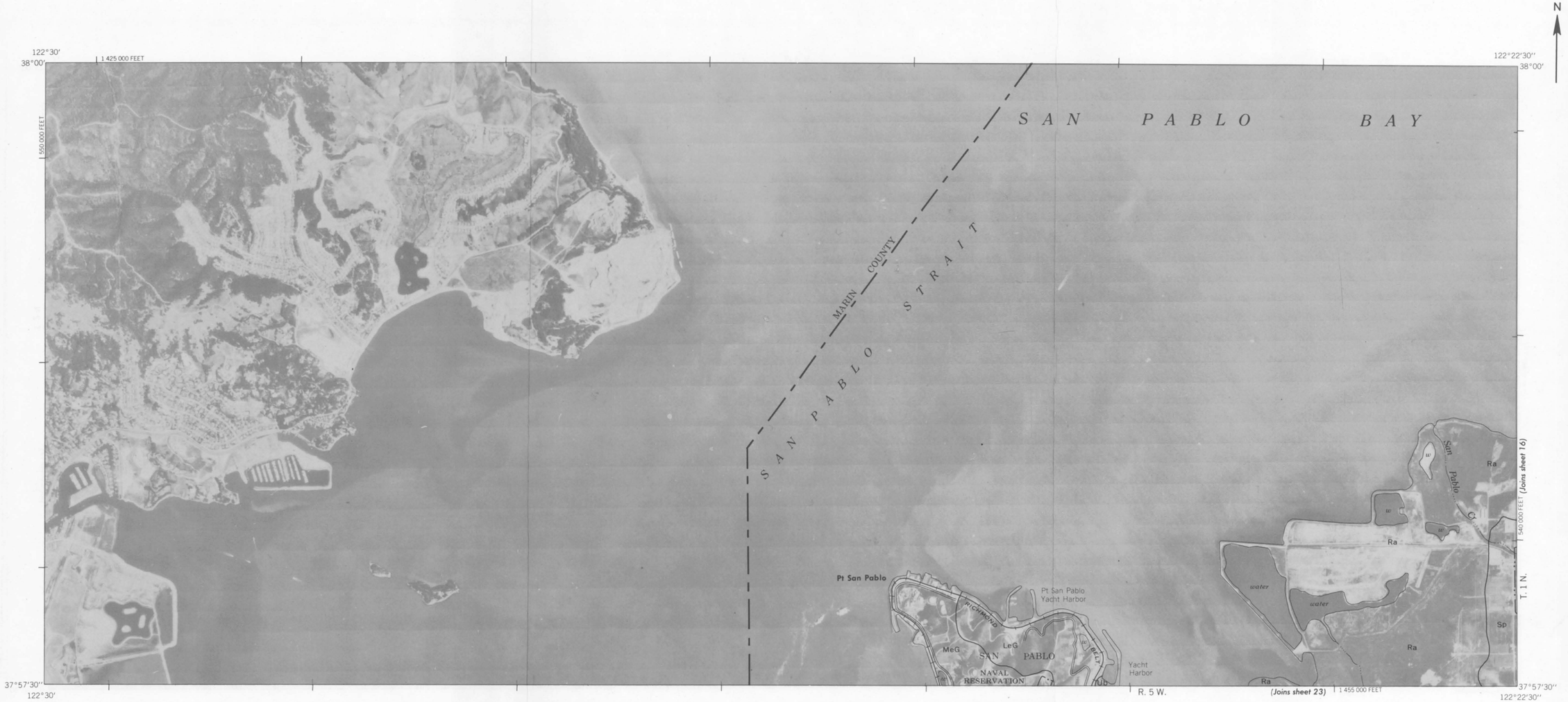

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1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000

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1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000

1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5' series maps. Lambert Conformal Conic projection. 1927 North American datum. 10,000-foot grid based upon California coordinate system, Zone 3.

CONTRA COSTA COUNTY, CALIFORNIA NO. 18

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

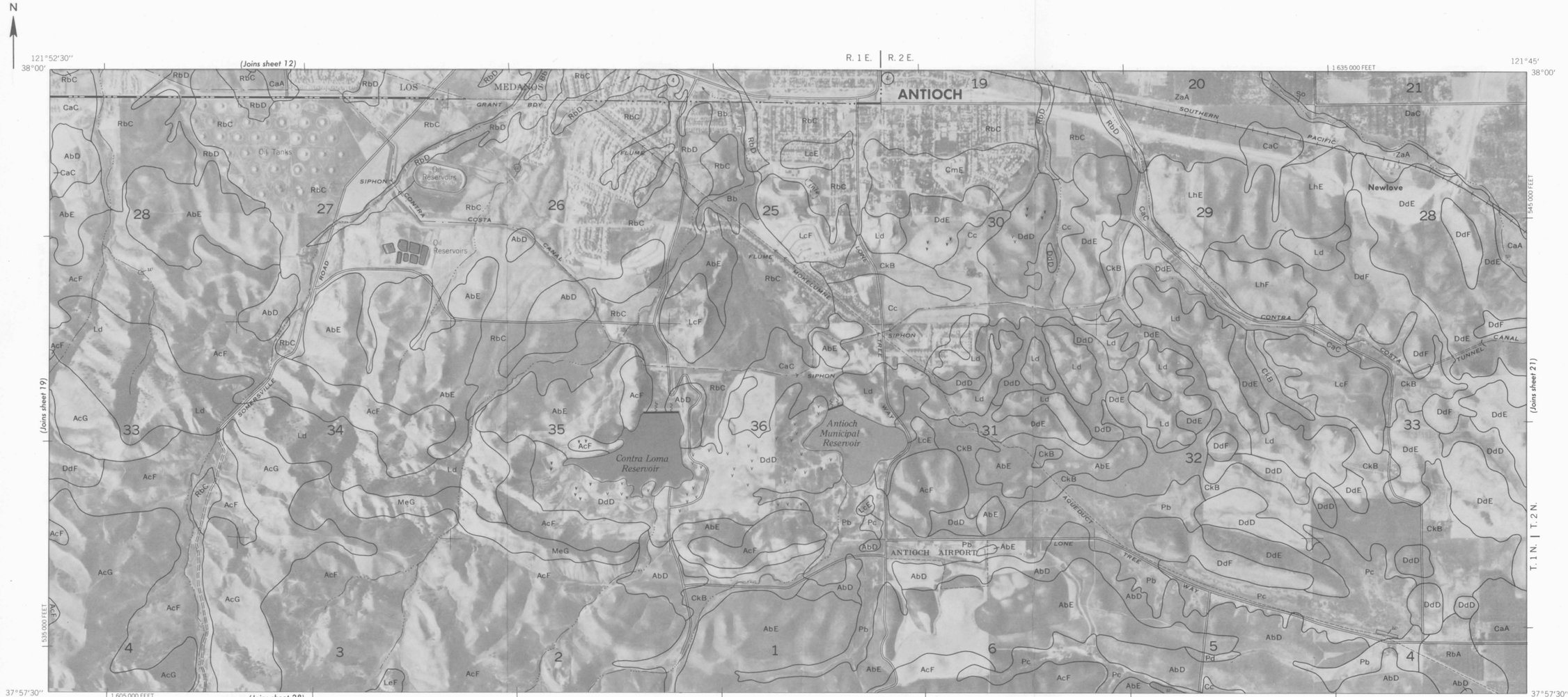
Land division corners are approximately positioned on this map.

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5' series maps Lambert Conformal Conic projection. 1927 North American datum, 10,000-foot grid based upon California coordinate system. Zone 3

1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000



1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5' series maps Lambert Conformal Conic projection. 1927 North American datum. 10,000-foot grid based upon California coordinate system. Zone 3

CONTRA COSTA COUNTY, CALIFORNIA NO. 20

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5′ series maps Lambert Conformal Conic projection. 1927 North American datum, 10,000-foot grid based upon California coordinate system. Zone 3

1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000

CONTRA COSTA COUNTY AREA, CALIFORNIA — SHEET NUMBER 22

1 ¾ ½ ¼ 0 1 2 Miles

5 000 4 000 3 000 2 000 1 000 0 5 000 10 000 Feet

Scale 1:24 000

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

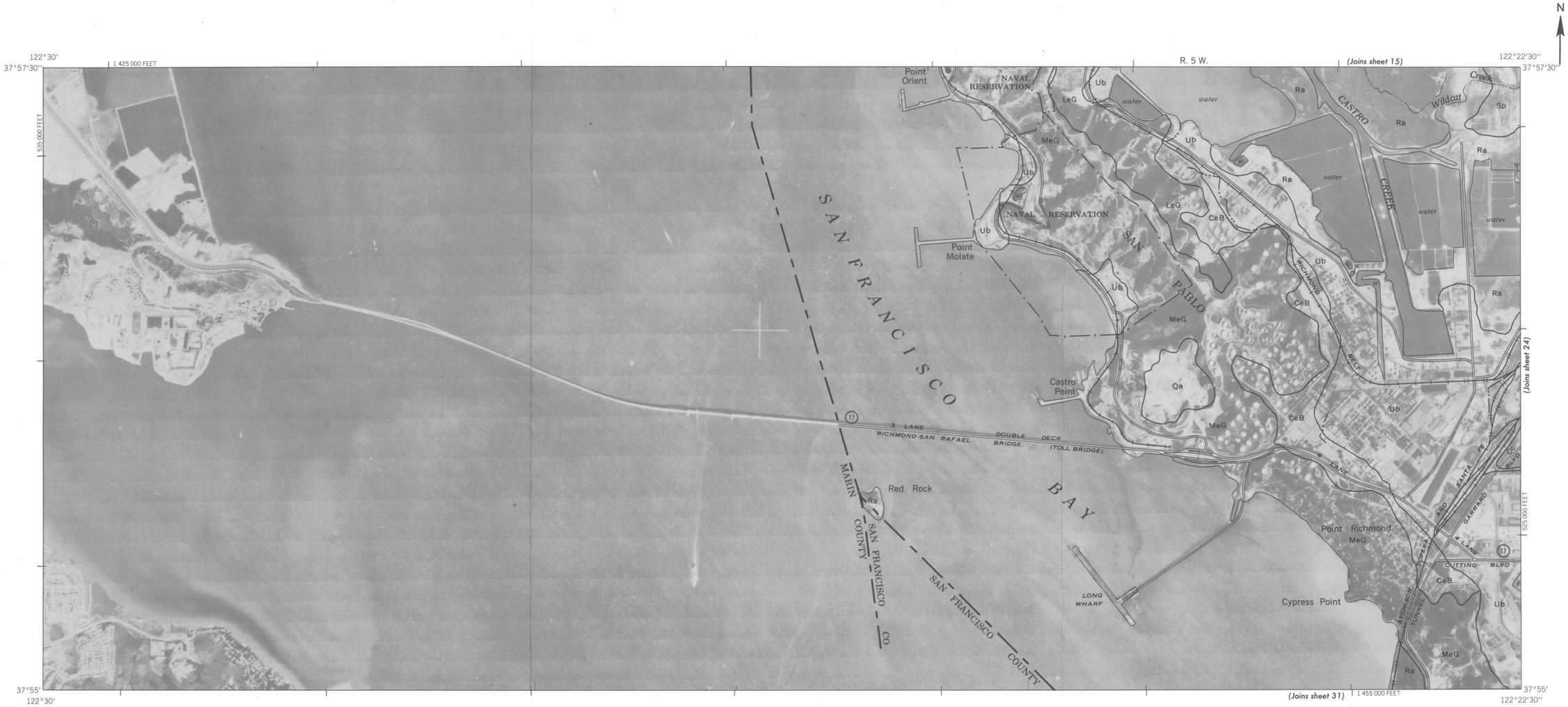
Land division corners are approximately positioned on this map.

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5' series maps Lambert Conformal Conic projection. 1927 North American datum, 10,000-foot grid based upon California coordinate system: Zone 3

CONTRA COSTA COUNTY, CALIFORNIA NO. 22

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

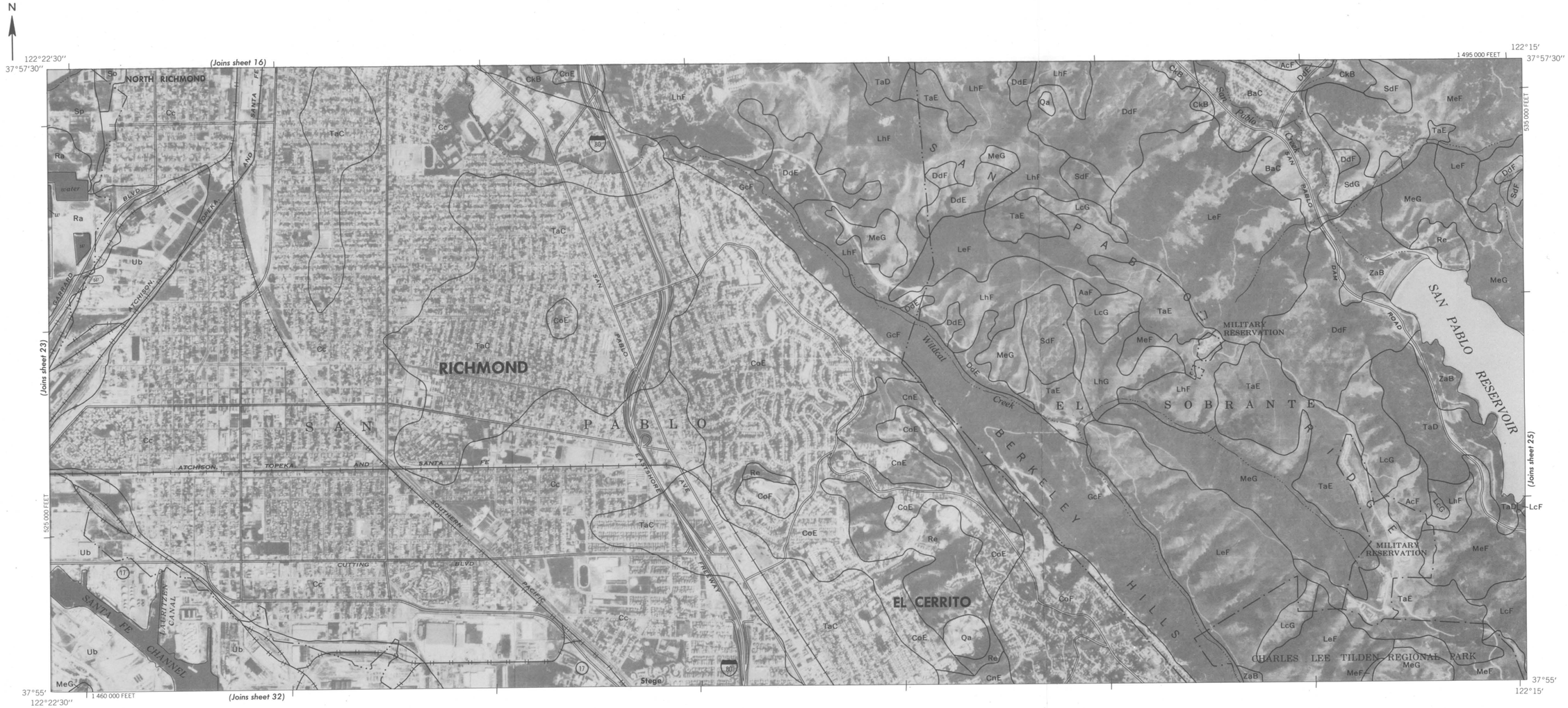


Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5' series maps. Lambert Conformal Conic projection, 1927 North American datum. 10,000-foot grid based upon California coordinate system, Zone 3

1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000



This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

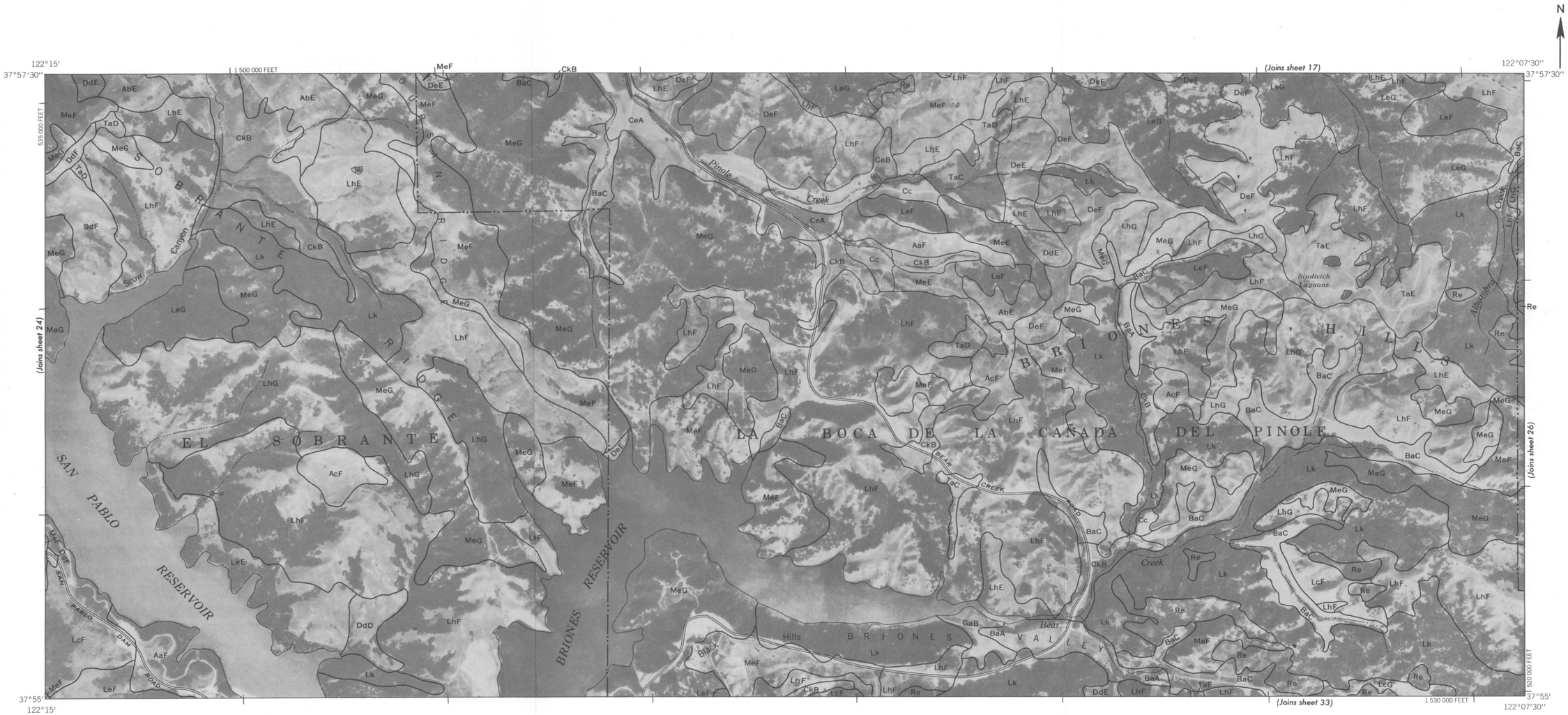
Land division corners are approximately positioned on this map.

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5' series maps Lambert Conformal Conic projection, 1927 North American datum, 10,000-foot grid based upon California coordinate system, Zone 3

CONTRA COSTA COUNTY, CALIFORNIA NO. 24

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.



Orthophotobase compiled by the USGS in 1970 Planimetric detail from USGS 7.5′ series maps Lambert Conformal Conic projection. 1927 North American datum, 10,000-foot grid based upon California coordinate system. Zone 3

1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000

1 3/4 1/2 1/4 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

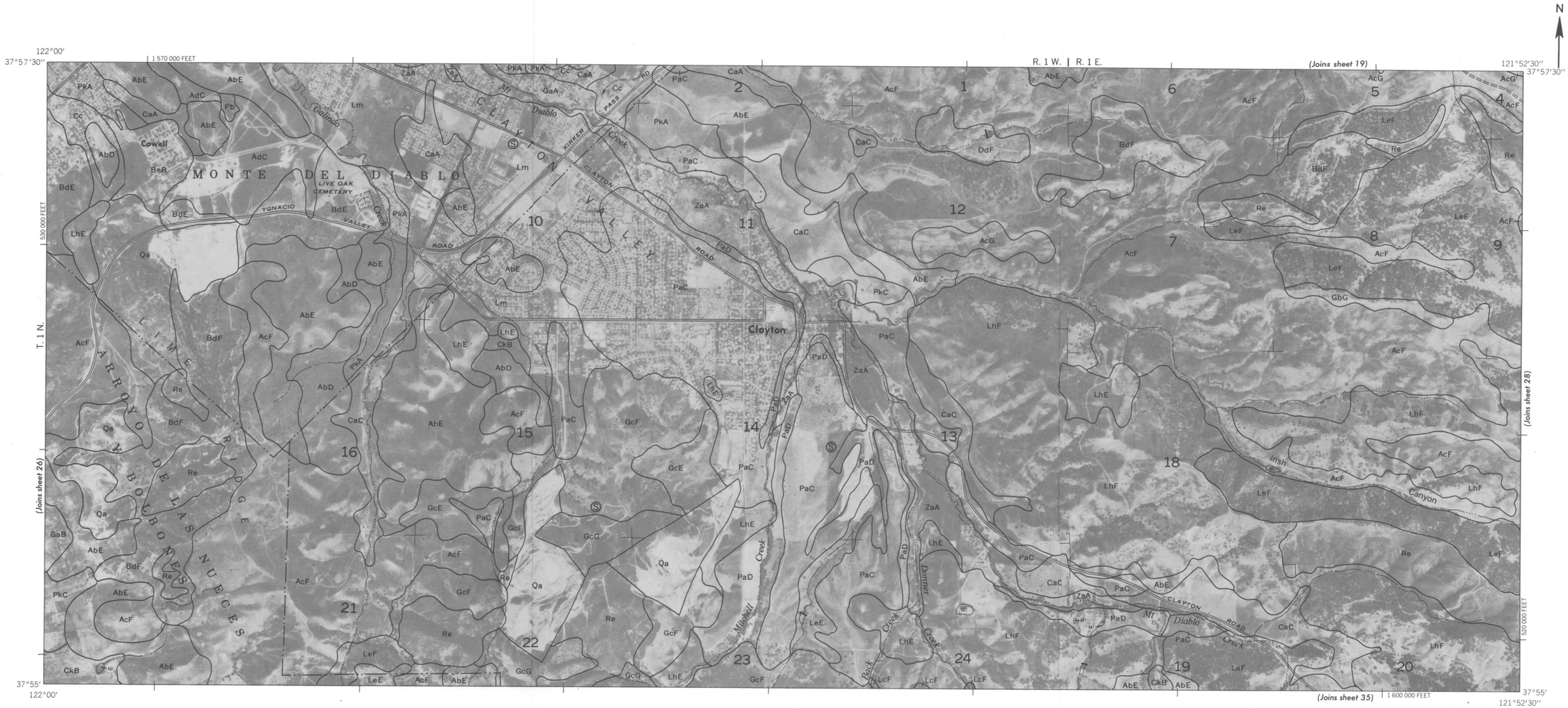
Scale 1:24000

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5' series maps Lambert Conformal Conic projection, 1927 North American datum, 10,000-foot grid based upon California coordinate system, Zone 3

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

CONTRA COSTA COUNTY, CALIFORNIA NO. 26



This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

Orthophotobase compiled by the USGS in 1970 Planimetric detail from USGS 7.5′ series maps Lambert Conformal Conic projection. 1927 North American datum, 10,000-foot grid based upon California coordinate system. Zone 3

1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000

1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

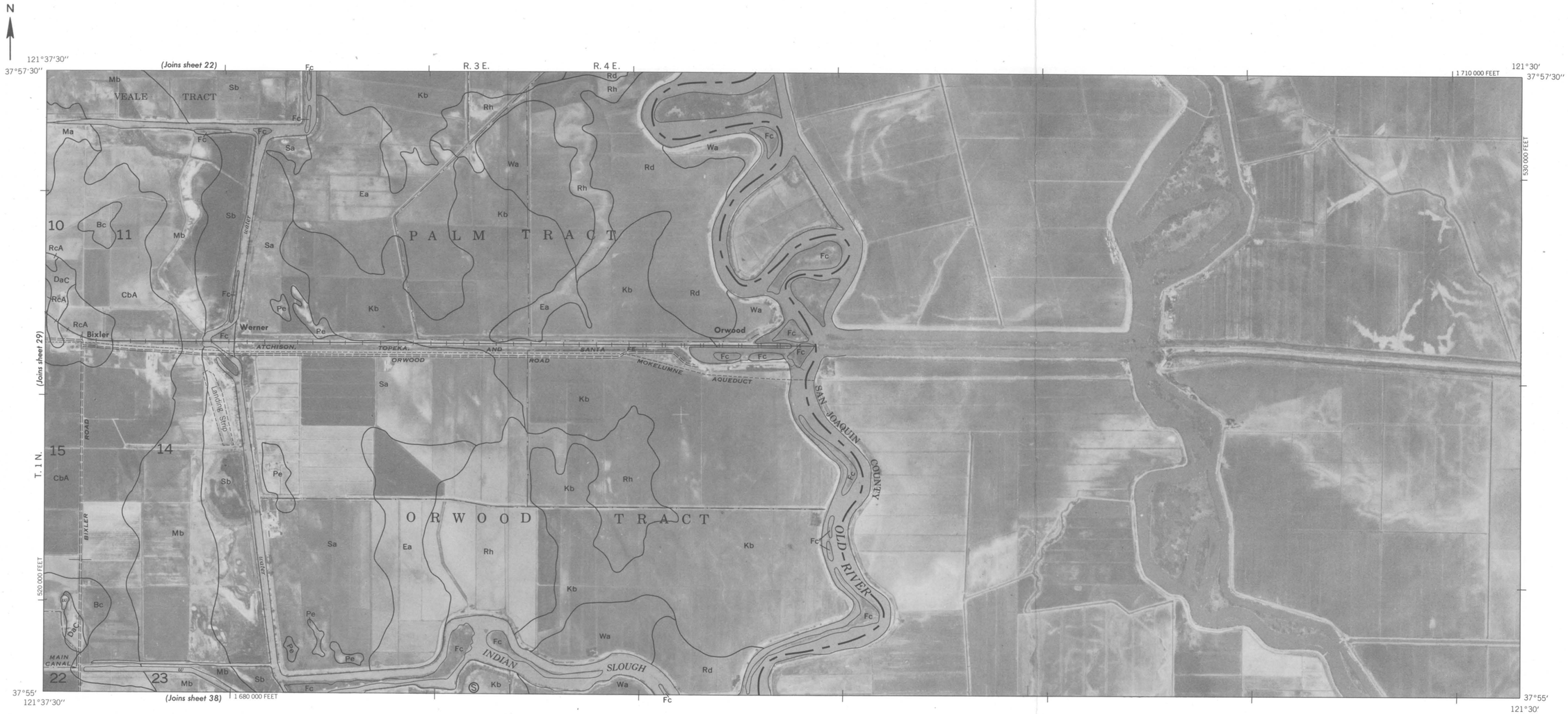
Land division corners are approximately positioned on this map.

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5′ series maps Lambert Conformal Conic projection. 1927 North American datum, 10,000-foot grid based upon California coordinate system. Zone 3

CONTRA COSTA COUNTY, CALIFORNIA NO. 28

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.



1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

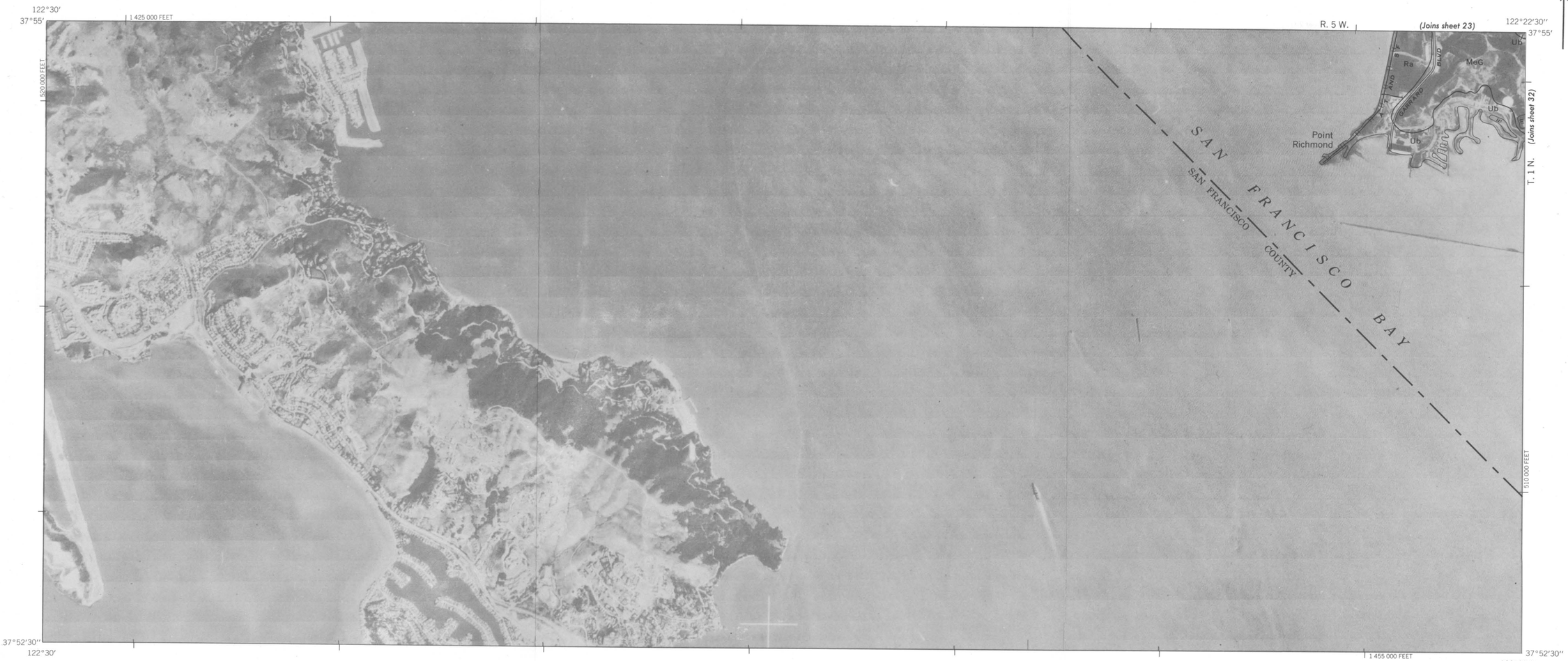
Land division corners are approximately positioned on this map.

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5′ series maps. Lambert Conformal Conic projection, 1927 North American datum, 10,000-foot grid based upon California coordinate system, zone 3

CONTRA COSTA COUNTY, CALIFORNIA NO. 30

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.



N

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5′ series maps. Lambert Conformal Conic projection. 1927 North American datum. 10,000-foot grid based upon California coordinate system, Zone 3

1 ¾ ½ ¼ 0 1 2 Miles

5 000 4 000 3 000 2 000 1 000 0 5 000 10 000 Feet

Scale 1:24000

CONTRA COSTA COUNTY AREA, CALIFORNIA — SHEET NUMBER 32

1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5' series maps Lambert Conformal Conic projection. 1927 North American datum, 10,000-foot grid based upon California coordinate system. Zone 3

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map

CONTRA COSTA COUNTY, CALIFORNIA NO. 32

CONTRA COSTA COUNTY, CALIFORNIA NO. 33

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5' series maps Lambert Conformal Conic projection. 1927 North American datum, 10,000-foot grid based upon California coordinate system. Zone 3

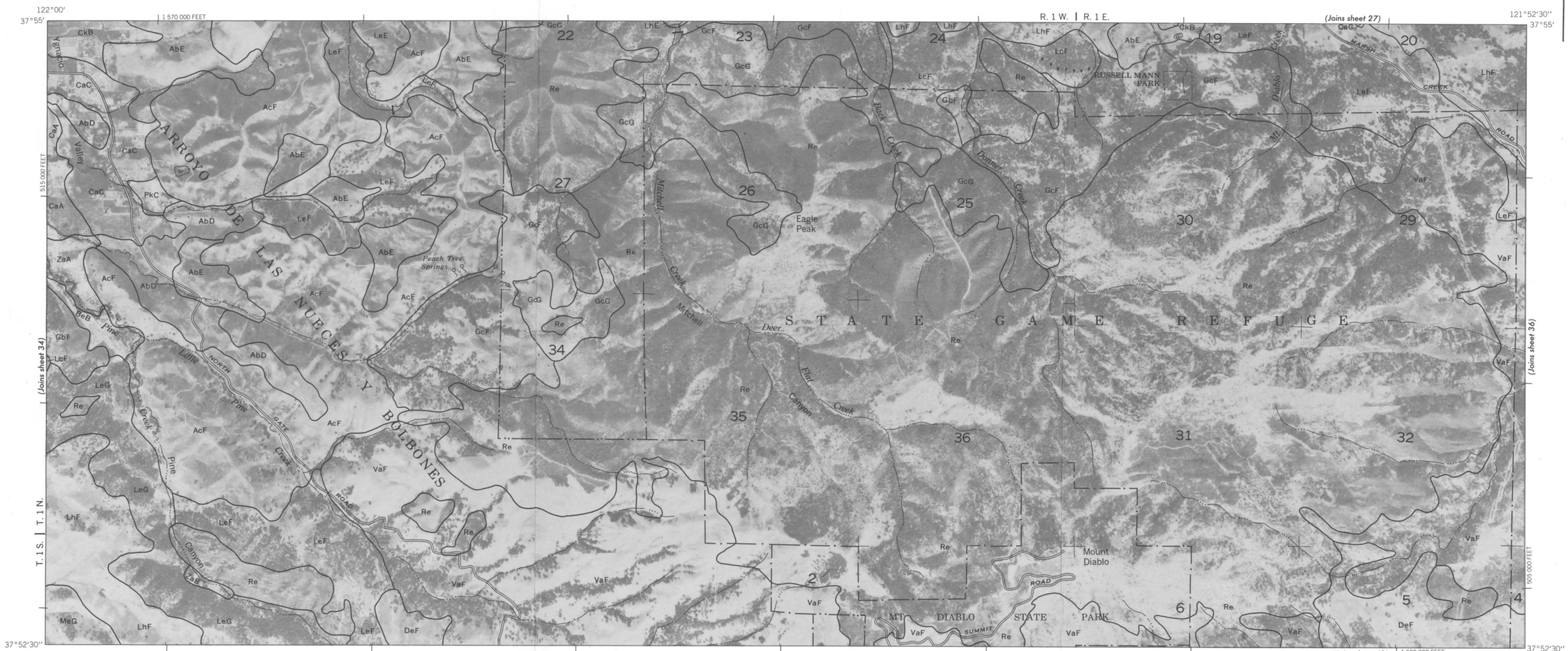
This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

CONTRA COSTA COUNTY, CALIFORNIA NO. 34

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

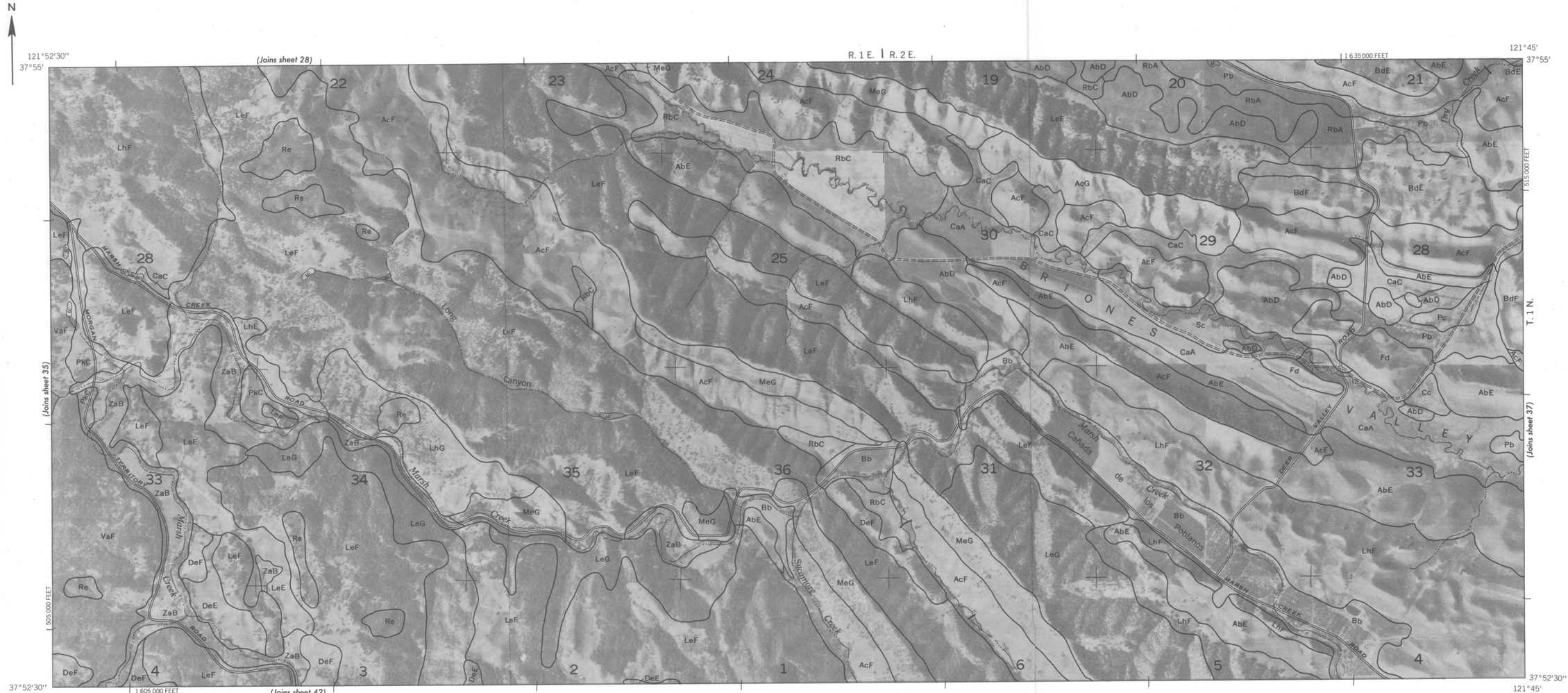


Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5′ series maps. Lambert Conformal Conic projection, 1927 North American datum, 10,000-foot grid based upon California coordinate system, Zone 3

1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000



This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5′ series maps Lambert Conformal Conic projection. 1927 North American datum, 10,000-foot grid based upon California coordinate system. Zone 3

1 ¾ ½ ¼ 0 1 2 Miles

5 000 4 000 3 000 2 000 1 000 0 5 000 10 000 Feet

Scale 1:24000

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5′ series maps. Lambert Conformal Conic projection. 1927 North American datum, 10,000-foot grid based upon California coordinate system, Zone 3

1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000

1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

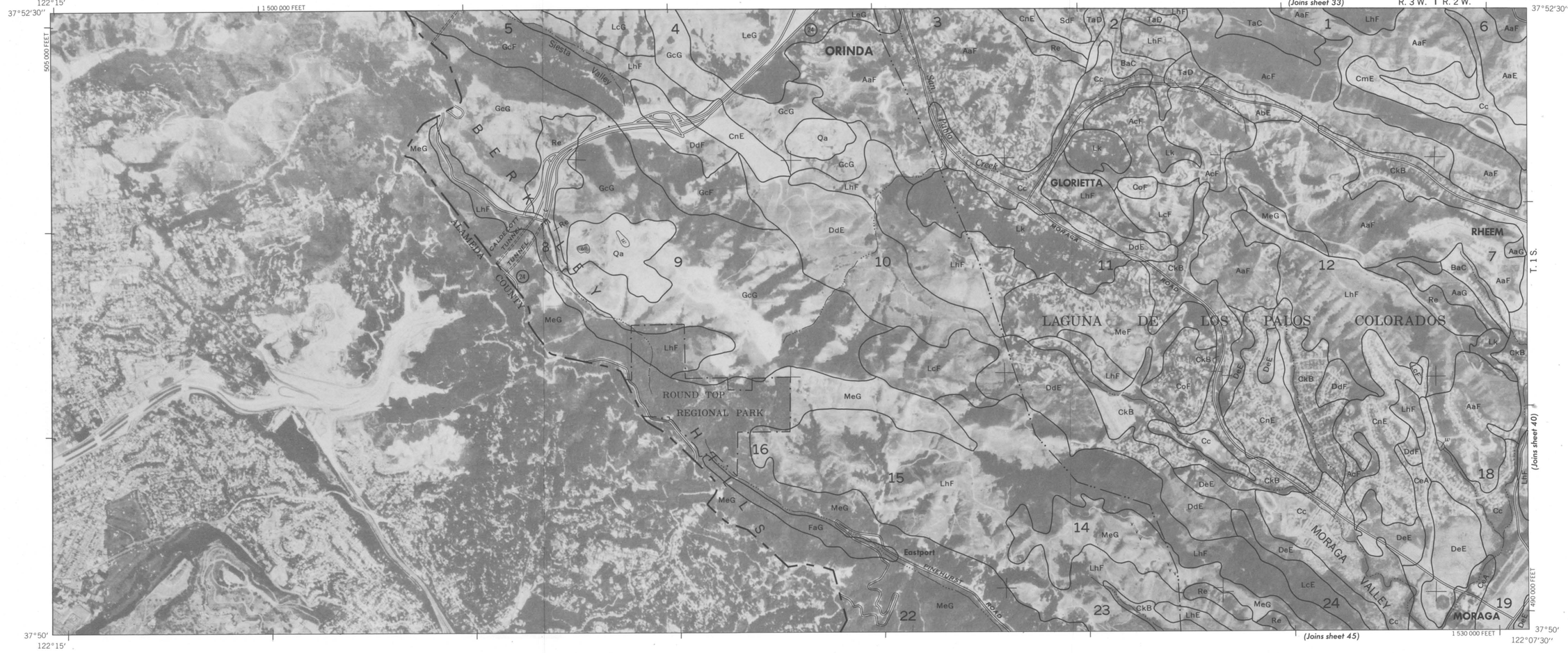
Scale 1:24000

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5' series maps Lambert Conformal Conic projection. 1927 North American datum, 10,000-foot grid based upon California coordinate system. Zone 3

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

CONTRA COSTA COUNTY, CALIFORNIA NO. 38



This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5′ series maps. Lambert Conformal Conic projection. 1927 North American datum, 10,000-foot grid based upon California coordinate system. Zone 3

1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 ′ 0 5000 10000 Feet

Scale 1:24000

CONTRA COSTA COUNTY, CALIFORNIA NO. 39

1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5' series maps Lambert Conformal Conic projection. 1927 North American datum, 10,000-foot grid based upon California coordinate system. Zone 3

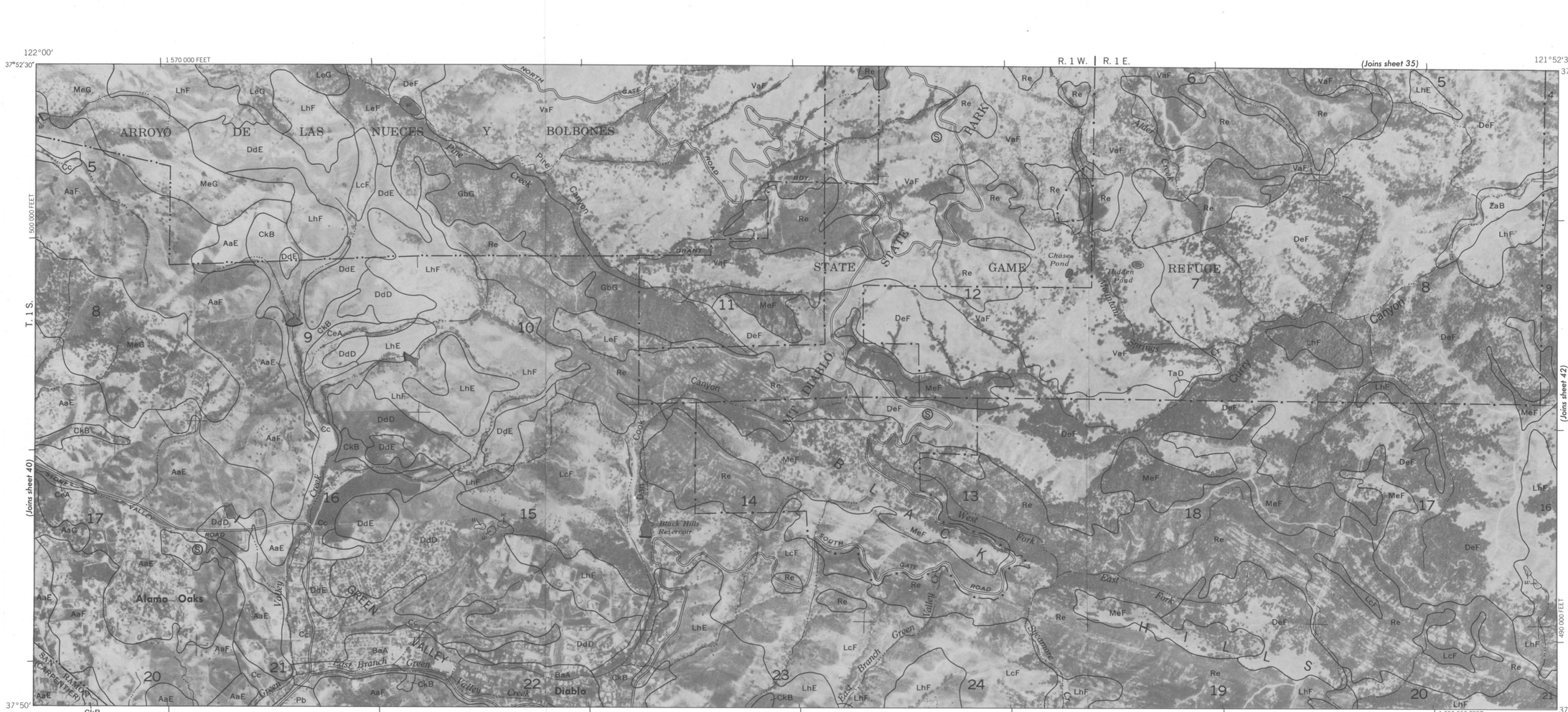
This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

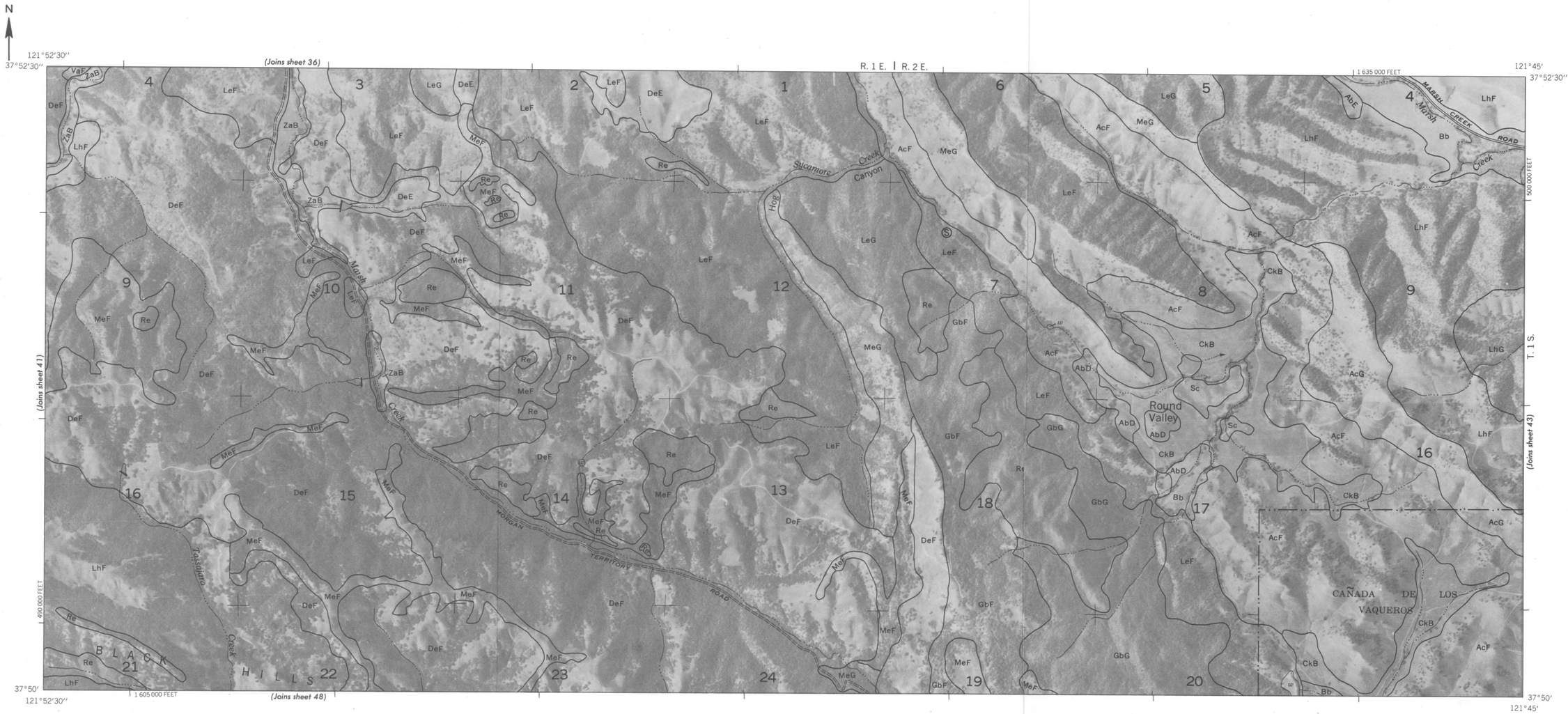
CONTRA COSTA COUNTY, CALIFORNIA NO. 40

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.



CONTRA COSTA COUNTY AREA, CALIFORNIA — SHEET NUMBER 42



1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5′ series maps Lambert Conformal Conic projection. 1927 North American datum, 10,000-foot grid based upon California coordinate system. Zone 3

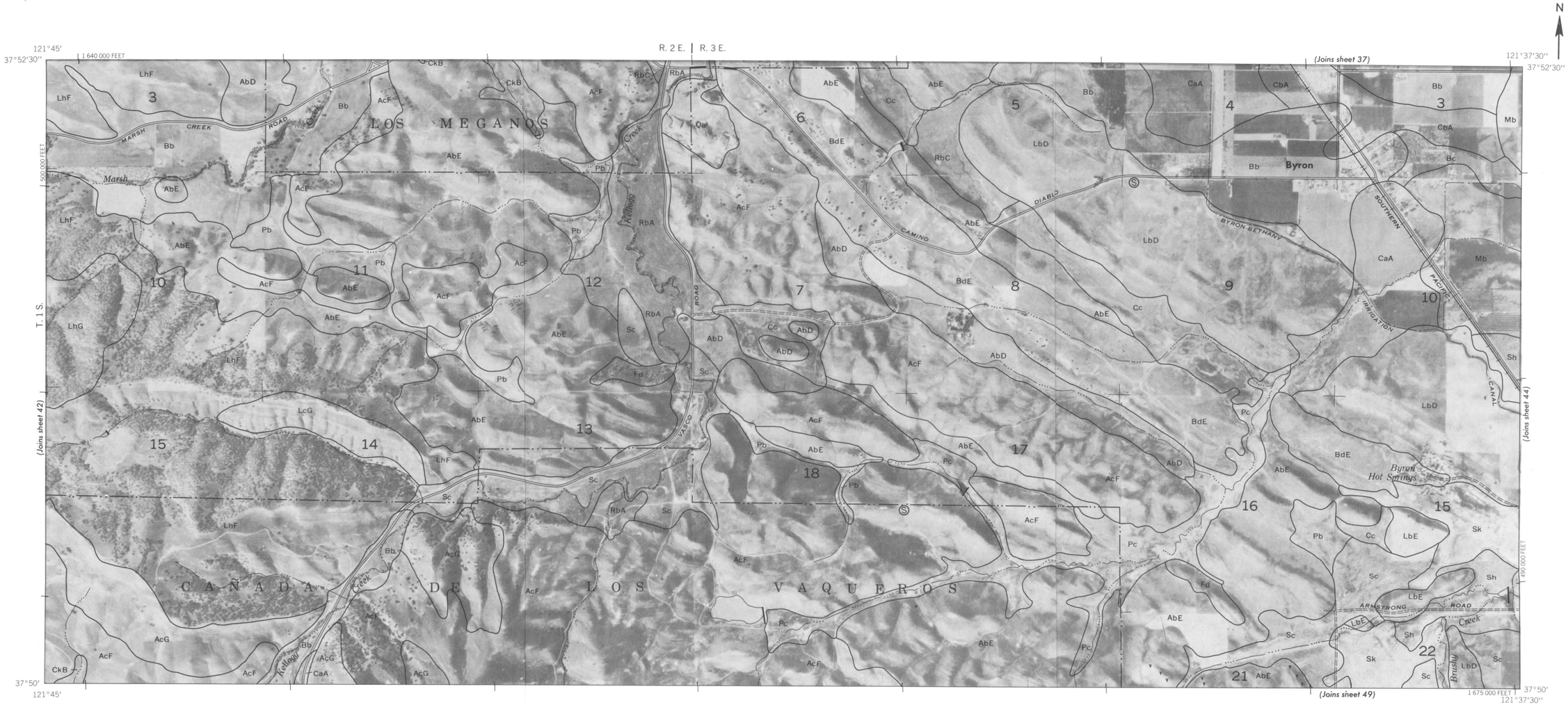
This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

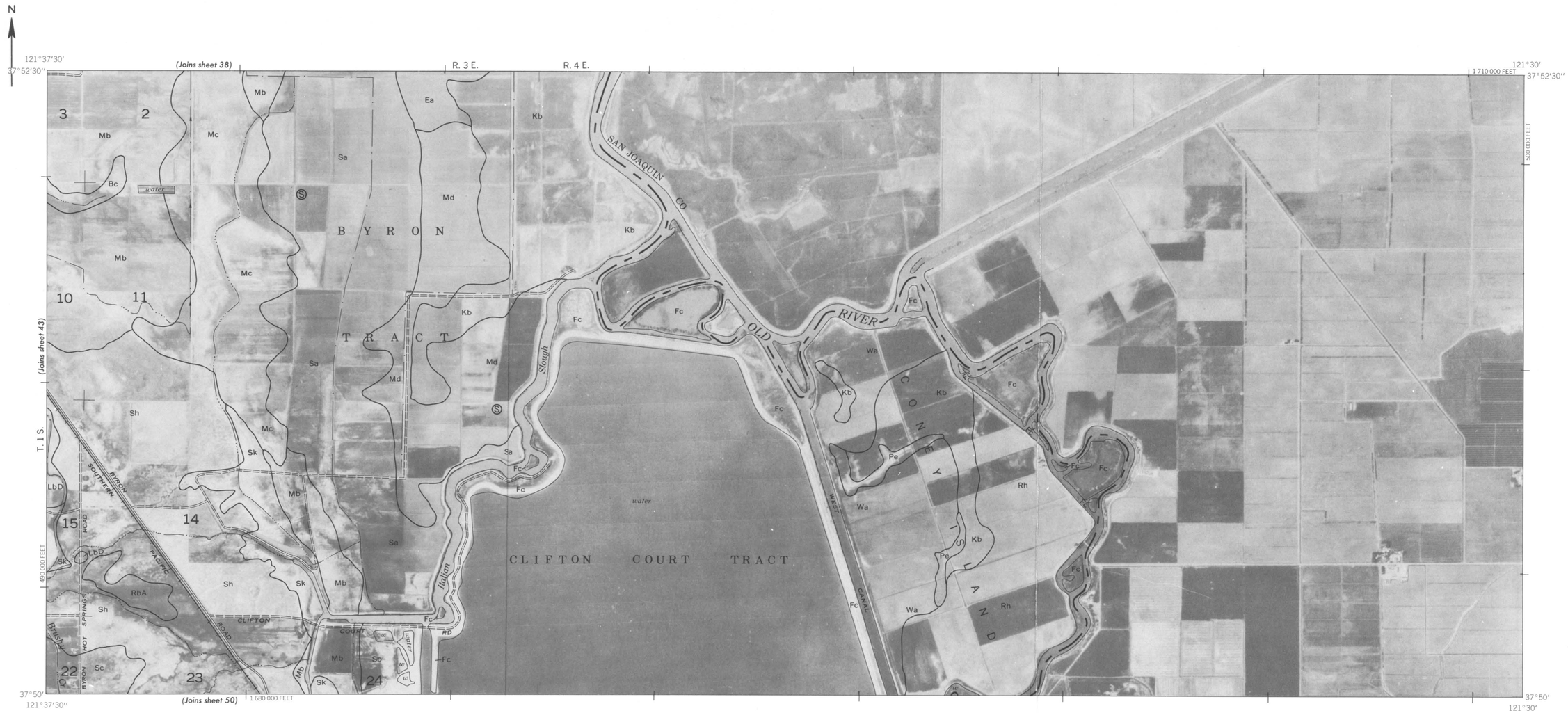
CONTRA COSTA COUNTY, CALIFORNIA NO. 42

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.



CONTRA COSTA COUNTY AREA, CALIFORNIA — SHEET NUMBER 44



This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5' series maps Lambert Conformal Conic projection. 1927 North American datum, 10,000-foot grid based upon California coordinate system, Zone 3

1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000

CONTRA COSTA COUNTY, CALIFORNIA NO. 44

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5' series maps Lambert Conformal Conic projection. 1927 North American datum, 10,000-foot grid based upon California coordinate system. Zone 3

1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000

1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5' series maps Lambert Conformal Conic projection, 1927 North American datum, 10,000-foot grid based upon California coordinate system, Zone 3

CONTRA COSTA COUNTY, CALIFORNIA NO. 46

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

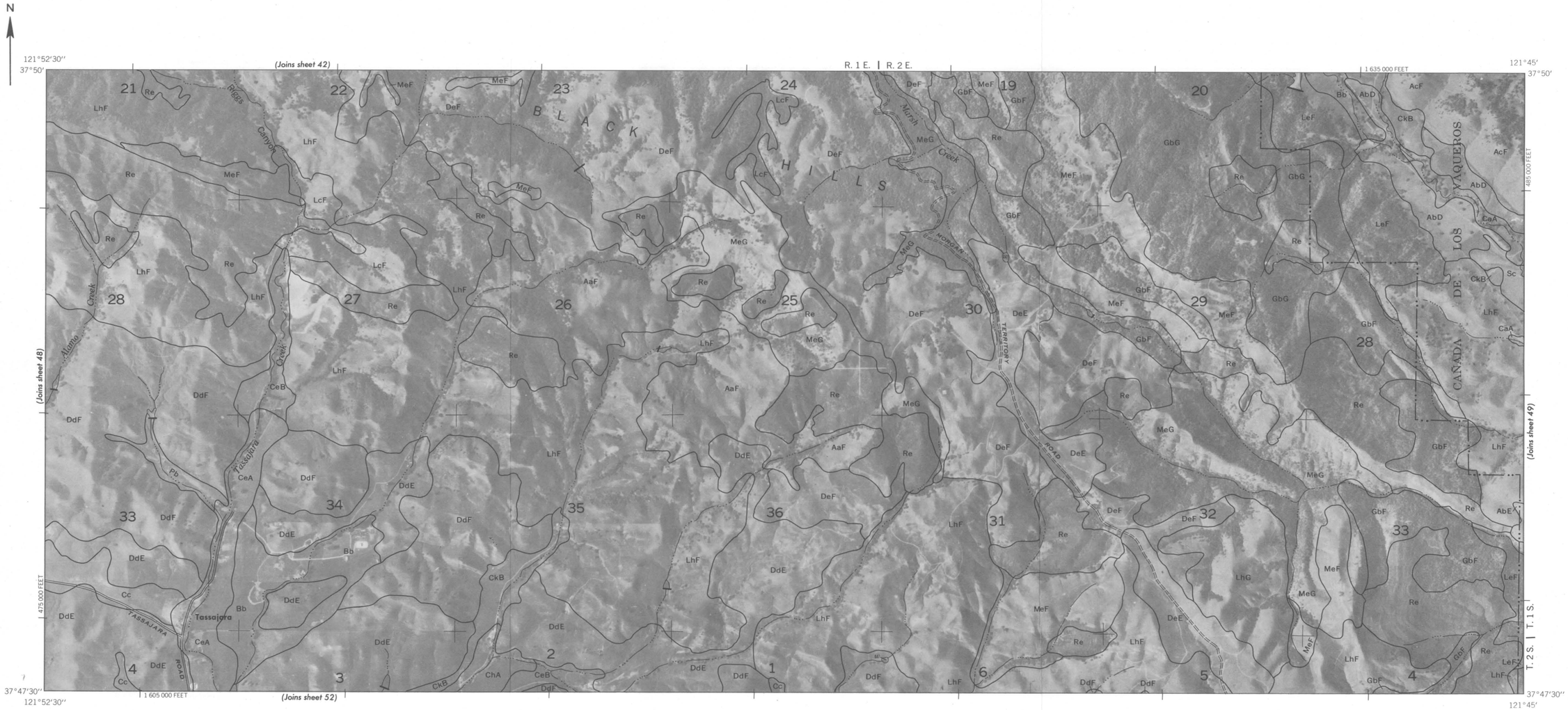
Land division corners are approximately positioned on this map.

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5′ series maps Lambert Conformal Conic projection. 1927 North American datum, 10,000-foot grid based upon California coordinate system. Zone 3

1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000



1 ¼ ⅛ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

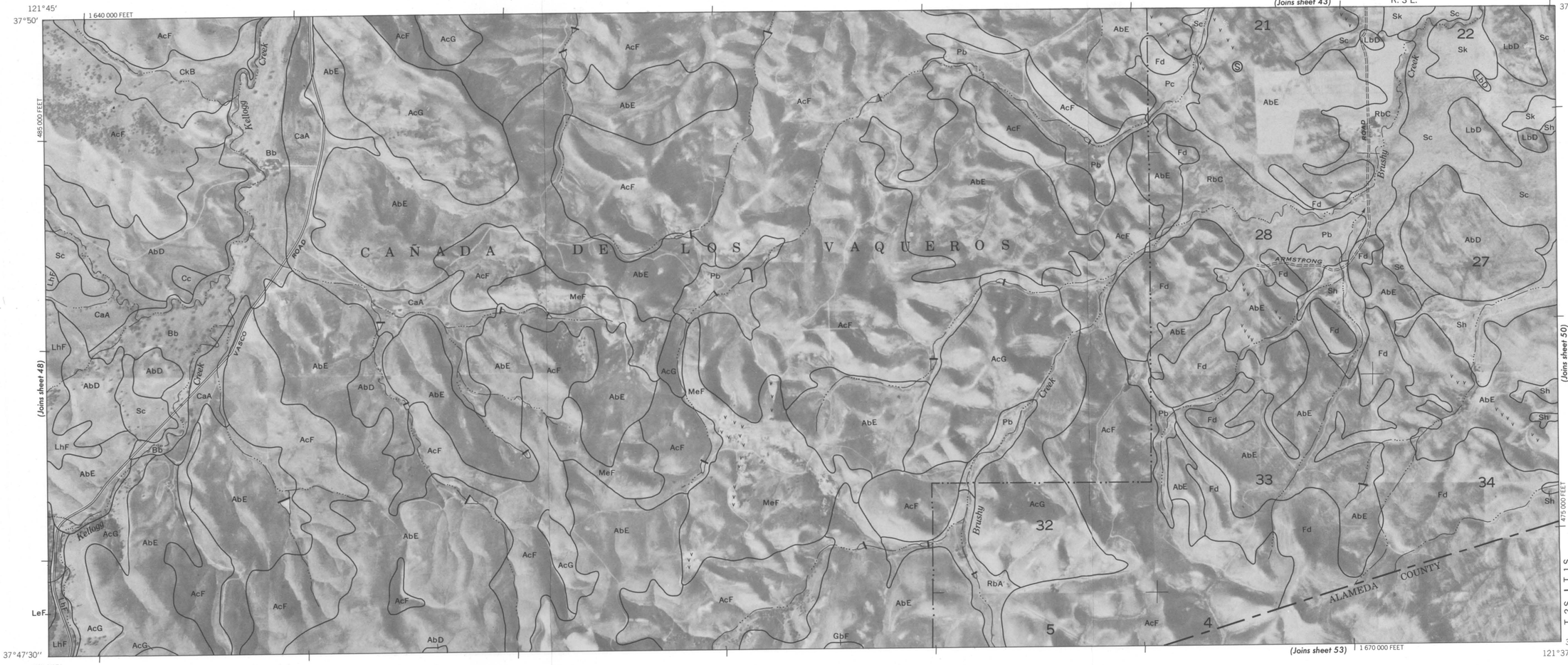
Land division corners are approximately positioned on this map.

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5′ series maps Lambert Conformal Conic projection. 1927 North American datum, 10,000-foot grid based upon California coordinate system. Zone 3

CONTRA COSTA COUNTY, CALIFORNIA NO. 48

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

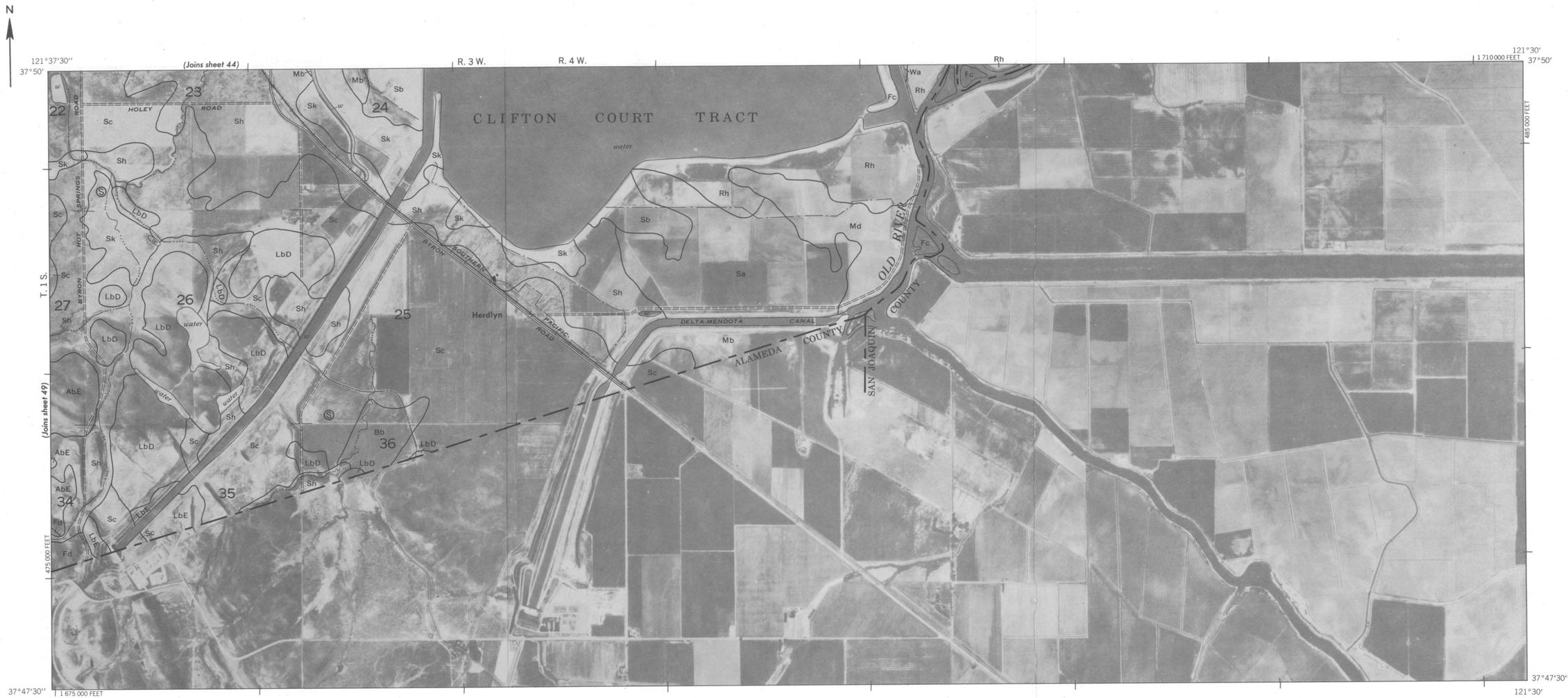


Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5′ series maps Lambert Conformal Conic projection. 1927 North American datum, 10,000-foot grid based upon California coordinate system. Zone 3

1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000



1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5′ series maps Lambert Conformal Conic projection. 1927 North American datum, 10,000-foot grid based upon California coordinate system. Zone 3

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

CONTRA COSTA COUNTY, CALIFORNIA NO. 50

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5′ series maps. Lambert Conformal Conic projection, 1927 North American datum, 10,000-foot grid based upon California coordinate system, Zone 3.

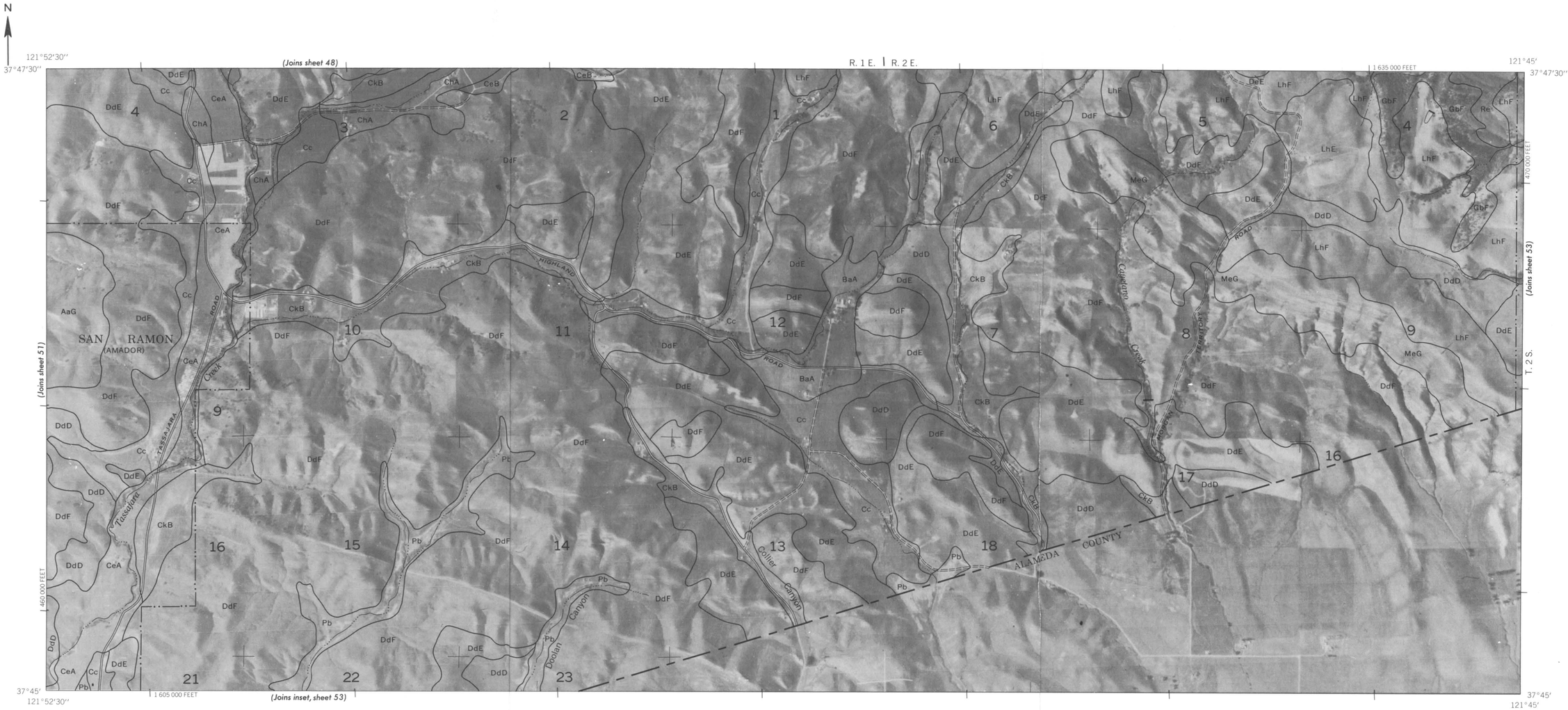
1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.



1 ¼ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5' series maps Lambert Conformal Conic projection, 1927 North American datum, 10,000-foot grid based upon California coordinate system, Zone 3

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

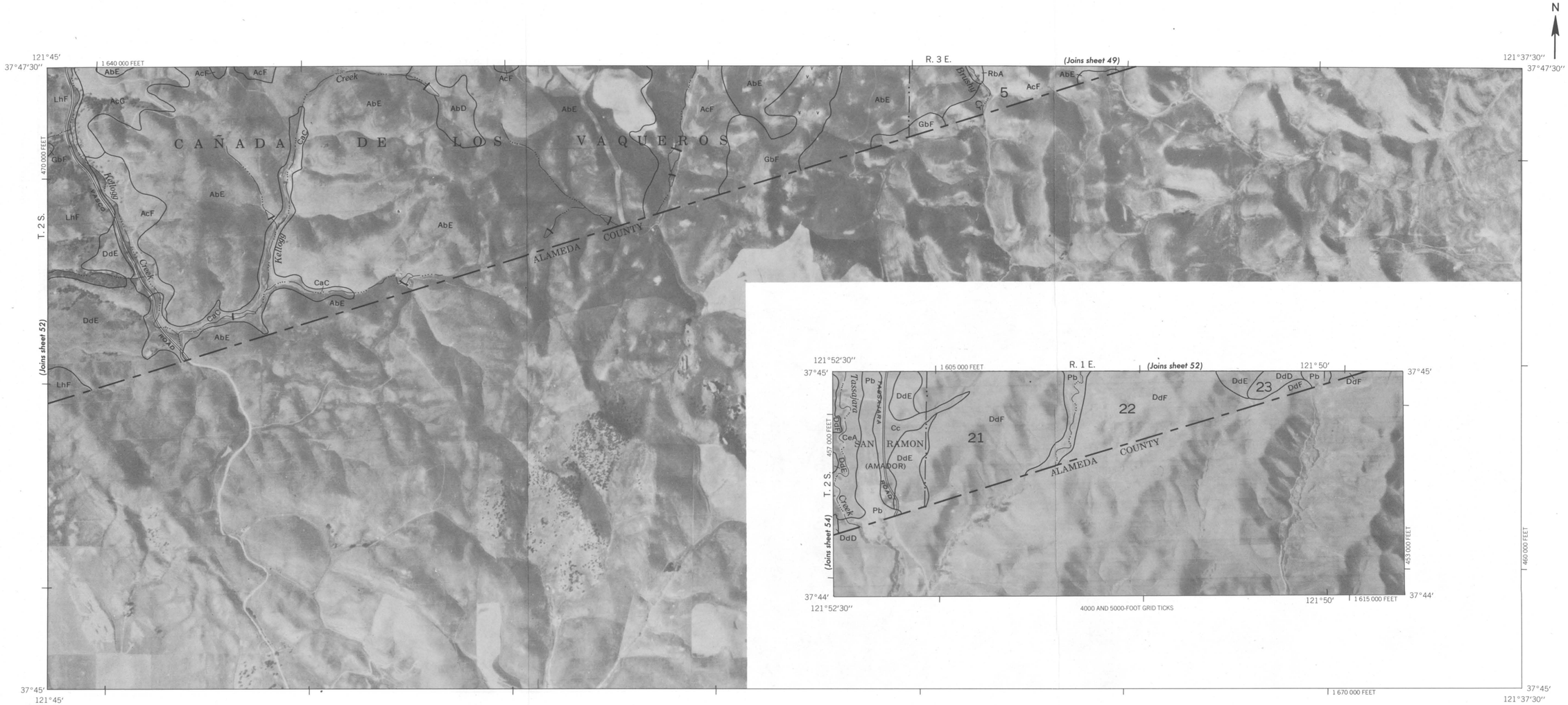
Land division corners are approximately positioned on this map.

CONTRA COSTA COUNTY, CALIFORNIA NO. 52

CONTRA COSTA COUNTY, CALIFORNIA NO. 53

This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

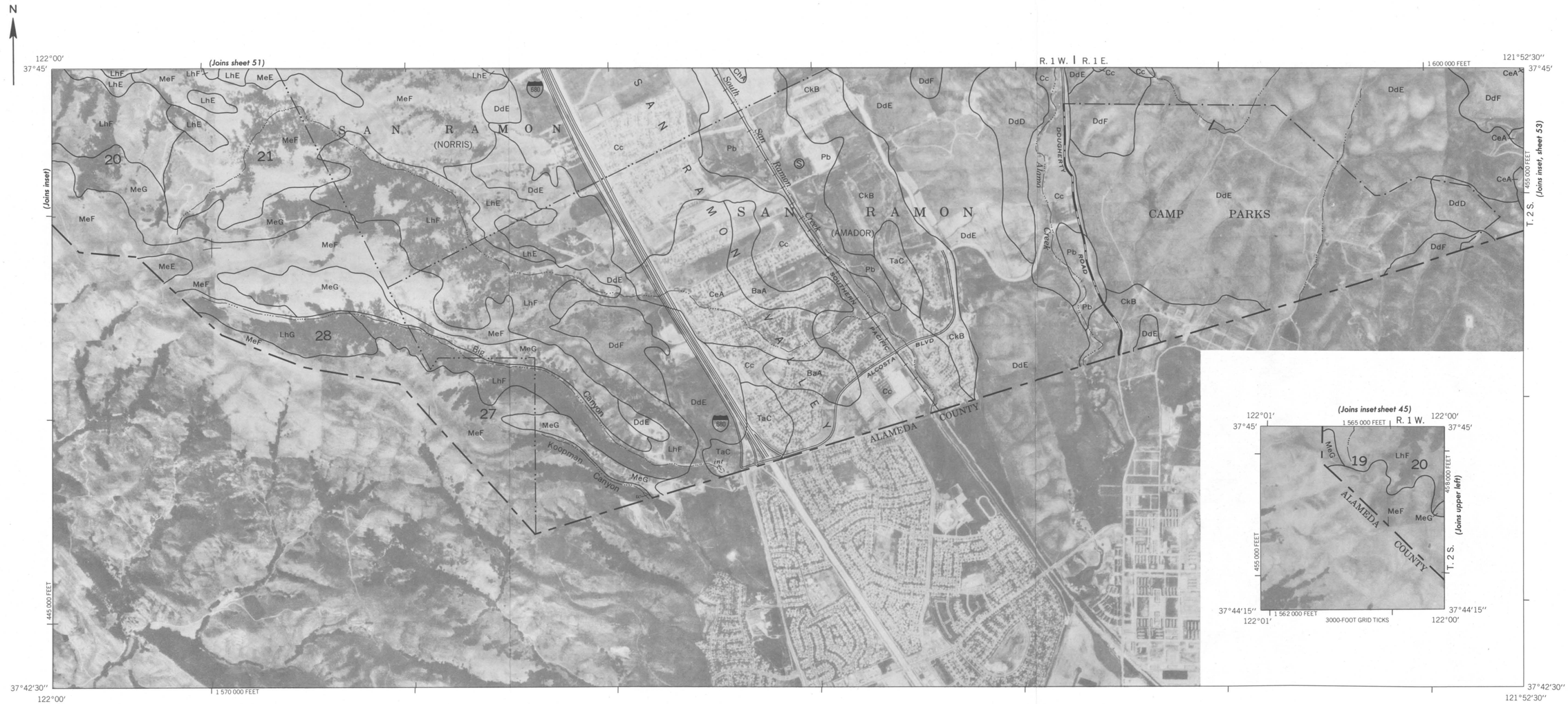


Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5′ series maps Lambert Conformal Conic projection. 1927 North American datum, 10,000-foot grid based upon California coordinate system. Zone 3

1 ¾ ½ ¼ 0 1 2 Miles

5 000 4 000 3 000 2 000 1 000 0 5 000 10 000 Feet

Scale 1:24000



This map is one of a set compiled in 1974 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

Orthophotobase compiled by the USGS in 1970. Planimetric detail from USGS 7.5′ series maps Lambert Conformal Conic projection. 1927 North American datum, 10,000-foot grid based upon California coordinate system. Zone 3